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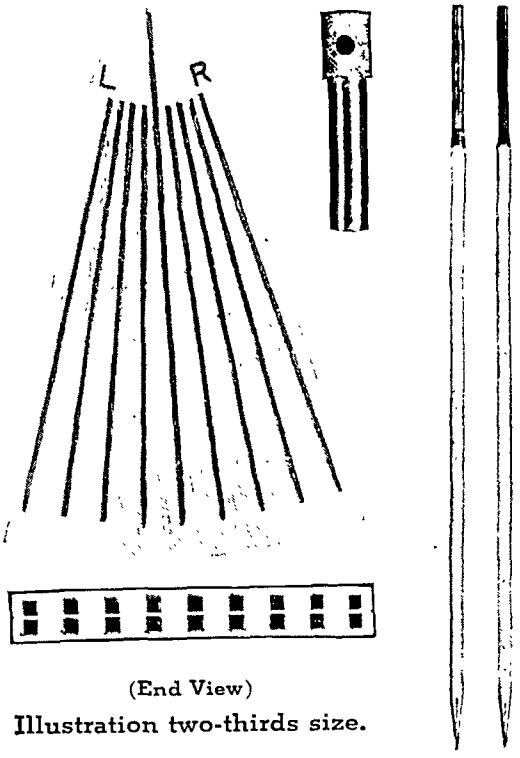
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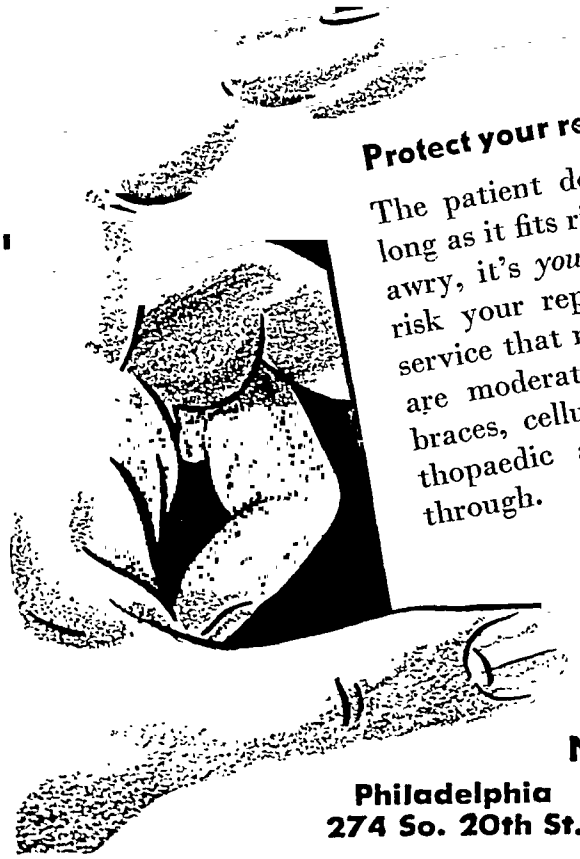
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In the first type of case, in which the aim is to restore the structures to their former relative positions, it is not advisable to insist upon or even to advocate too exclusively one method of reuniting the fragments. The essential principle is practically the same in all of the different procedures. In some, the surface is cleared of fibrous covering and thoroughly refreshened; in all, the fragments must be replaced and held in firm apposition. In the old cases, in which bone atrophy always exists, this firm contact is particularly imperative. Whether this retention is accomplished by interposition of bone grafts, nails, or wires for fixation of the limb with or without artificial impaction, the maintenance of this contact is imperative in proportion to the diminished size of the head fragment and the amount of existing bone atrophy. In some of these cases the advisability of extraneous material, with the local trauma incident to its insertion, is decidedly debatable. It is the author's belief that sound surgery demands the largest possible contact of cancellous bone on each fragment and the least amount of extraneous material placed in these parts. The transplantation of the head fragment to the freshened upper and inner surface of the trochanter, with so large a surface of bone contact, in a position which does not tend to displace, frequently provides the best physiological conditions for quick return of vitality to the head fragment.

In the other type of case, in which there is not sufficient normal structure remaining to permit joint function, the choice of procedure is somewhat more difficult. With the marked atrophy of the head, the thinning or disappearance of the cartilage line, and the arthritic changes around the joint, either about the femur or the acetabulum, or both as is usually the case, the potential for good function (weight-bearing and motion without pain) is not offered. It is necessary to estimate how much function, based on the consideration of both local and general conditions, as well as on the social status, it is possible to expect, and then to select that operative procedure which seems best fitted to fulfill these indications. We must choose between the use of the remaining articular structures placed in contact with the acetabulum, with the object of obtaining a pseudarthrosis—whether by the method of Whitman, by putting the lesser trochanter into the cavity of the acetabulum, or by some of the more recent modifications of reconstruction operations—or an immediate ankylosis, sacrificing the convenience of motion to the greater strength and to the more practical use of painless weight-bearing.

The various operative procedures with their rather refined techniques and the many mechanical devices which may be employed have been so elaborated and often perfected, and the different conservative measures with their results have been so freely given to the medical public, that we have now quite a sufficient equipment to meet whatever conditions are presented. At present there is need of special study and observation, particularly by the collection of end results, to aid in the application of these methods which we already have to the various types of cases, and to act as a guide in the choice of the method of treatment. The result

selected, the following features are to be taken into account: the character of the break; the amount of absorption of the neck; the size of the head and the amount of atrophy; the condition of the acetabulum and, in fact, of all the remaining structural elements of the joint which may be used in restoring function by whatever method the operator may decide to employ. Of equal importance with the local factors are the general factors,—namely, the age; the general condition; the amount and kind of activity engaged in by the patient; and the demands which his social status will put on the restored joint.

The various accepted methods of operation, with their modifications, can be easily put into two groups, according to the principles upon which they are based and the goal which they attempt to reach:

1. Those which, in the presence of intact articular structures, aim to preserve the parts and to restore as far as possible the normal architecture of the joint.

2. Those which, in the absence of normal joint structures, are destructive in principle and aim to use non-articular structures to perform a portion of the rôle of the normal joint structures.

The former attempts to restore to the joint a large percentage of normal function; the latter makes no such attempt, but, with the use of other non-articular structures, endeavors to regain as much of the normal function with weight-bearing as existing anatomical conditions can with reason promise. The employment of the first type presupposes the presence of articular structures sufficiently normal to resume joint function when the architecture has been sufficiently restored; the other accepts the damaged parts as a fact and endeavors to use them to the best advantage, recognizing that an imperfect joint must be accepted as a final result. Each case calls for an estimate of its potential capacity for function, based on the condition of the joint structures which remain.

In this estimate, it is necessary to formulate the essentials of a normal joint,—namely, (1) normal area and line of the joint cartilage; (2) freedom from arthritic changes; (3) preservation of a reasonable degree of bone density of the head fragment. It is a fact that some degree of change in the structure of an uninjured joint is compatible with satisfactory use, but it must be recognized that, after so severe an injury, these changes gradually become more pronounced, with a resultant increasing incapacity. Therefore, when these articular changes exist, even if they are not pronounced, the joint is not likely to stand the test of time and of the stress of an active life. These facts must be reckoned with in planning for the late end result, and these local conditions must influence the choice of procedure. Along with this, the social status of the patient makes equally strong demands for recognition and often must be the important deciding factor. The decision, therefore, must be made as to whether we shall attempt to restore, as far as possible, the normal architecture and function of the joint, or whether we shall compromise and be content with a less perfect end result.

# COMMENTS ON INTERNAL FIXATION IN FRESH FRACTURES OF THE NECK OF THE FEMUR *

BY W. W. PLUMMER, M.D., BUFFALO, NEW YORK

The whole problem of the treatment of fresh fractures of the neck of the femur has been so thoroughly discussed in the literature that it is unnecessary to undertake a preliminary presentation of the history of the development of this procedure. It is sufficient to state that, since Smith-Petersen's work in 1931, there has been a rapidly growing conviction on the part of many surgeons that internal fixation of these fractures is the ideal method of treatment for this group of serious and disabling injuries.

In this paper the reader will recognize the influence of the work of many men who have already demonstrated the fundamentals in this particular field. Without later specific references to writers or to details of method, the author wishes to pay tribute to the courage and ingenuity of Smith-Petersen, Johansson, Gaenslen, Moore, Wescott, White, and others who have contributed to the development of this excellent operation. Our own personal experience with internal fixation of hip fractures, while brief in time, includes enough cases to warrant the expression of an opinion as to the general desirability and justification of this method of treatment.

## ANALYSIS OF CASES

Since September 1935 and up to May 1, 1937, there have been referred to our Service in the Buffalo General Hospital a total of thirty-seven consecutive cases of fresh fracture of the femoral neck. Of these patients, two died almost as soon as they were admitted to the Hospital. All of the remaining thirty-five patients were operated upon and some form of internal fixation was employed. Thirty-three cases would properly be classed as intracapsular fractures, while two were fractures at the base near the trochanter. The ages of the patients ranged from forty-six to ninety-two, and at one time the average age was seventy-eight. Lately the average has fallen to about seventy-five. Nine of the thirty-five patients in this series have died,—two within the ten-day postoperative period. The other seven survived for periods varying from one month to eighteen months, and died of cancer, incorrigible diabetes, and other causes due to their senescent state.

## RESULTS

The immediate postoperative results in this series of cases would alone, in the author's opinion, be sufficient justification for the internal-fixation operation. The patient is comfortably and easily cared for in

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 2, 1937.

after a few months, or even after a few years, may not furnish accurate evidence for the estimation of the value of the procedure. Even the mechanical irritation accompanying the use of an imperfect joint may be sufficient to change the first indication of success into the final fact of failure. These joints, traumatized by the original injury and later by operation, show marked anatomical and pathological defects and they often continue to exhibit progressive changes in their character, so that true end results cannot be estimated until after a much longer period than that of the usual fracture case.

The definite demand at present is not the study of the end results of a special method of treatment or of a particular technique. These various procedures have been given sufficient prominence to enable any surgeon of ability and experience to use any one with precision. What is needed is a more thorough study of the various conditions which these different joints present, with the means of estimating the potential capacity of each to respond to the demands which the activities and the social status of the patient will make on it in the years which follow, in order to determine which operation promises to give the type of joint best suited to the individual's needs. We should have more knowledge of end results obtained by the various procedures which have been selected with reference to the potential function which remains to a joint after it has passed through the trauma of the injury and the superimposed trauma of any operative procedures. Such data would aid us to choose more wisely the course to pursue.

that we classify our end results in terms of walking function without relapse into varus—external-rotation deformity—rather than by roentgenographic interpretations of the extent of the bony trabeculation bridging the fracture line. What will ultimately become of the nonvitalized head, if such it is in cases without bony union, still remains to be determined after a longer and more extensive experience.

### TYPE OF OPERATION

From the start of our series we have elected to reduce these fractures and to fix the fragments without opening the hip joint. All of the patients have been operated upon by way of the lateral thigh incision, exposing the trochanter and adjacent shaft. This plan was followed for the same reasons as have been given by other men advocating this type of operation.

The operation involves additional apparatus and equipment in that it requires efficient x-ray facilities in the operating room and some special instruments of precision. However, it makes possible the benefits of internal fixation for many frail and aged patients who could not possibly be expected to survive both a hip fracture and an arthrotomy. Also the author believes that in an arthrotomy the section of many of the supporting tissues of the hip joint, including the capsule, has often led the surgeon to the faulty assumption that open reduction is necessary.

### METHOD OF REDUCTION

In general, we have followed the Whitman-Leadbetter procedure of reduction, in which the injured leg is fixed in full internal rotation, with such flexion and abduction as seems wise. Apparently in practically all of our cases the posterior capsule was sufficiently intact to act as a splint for the reduced fracture and to hold the fragments in firm contact when the leg was fully rotated inward. In two cases, internal rotation rolled the neck fragment onto the front of the head, and lateral traction was necessary to adjust the fragments. When anteroposterior and lateral roentgenograms showed the reduction to be satisfactory, the position of the leg was not shifted until the operation was completed. This was accomplished by a special table which, by means of mechanical devices, was readily adjustable to any desired leg position and maintained a continuously fixed relationship between the femur and the x-ray projection apparatus. This complete and continuous mechanical holding of the injured leg, plus an x-ray technique which produces uniform roentgenograms of the hip joint from accurately standardized distances and angles, constitutes the most important part of the operation. In fact, the writer feels that the recent remarkable advances in roentgenography have made it possible to transform the so-called "blind hip-nailing operation" into a precision procedure.

### FIXATION INSTRUMENTS

In our series we have used Kirschner wires, Austin Moore pins, and

bed, he has no pain, and he is completely relieved of the apprehensions of a long and exhausting bedridden period in plaster or traction.

It would, of course, be ridiculous to discuss end results in this series, but a rough analysis of functional results is interesting. Twenty-six of the patients are living. Four have been operated upon too recently to be counted at this time; the remaining twenty-two are comfortably ambulatory, their functional ability apparently depending on their age and general condition rather than on what might be termed their actual hip function, which seems to be good.

With the exception of one hip with a fracture near the trochanter, none of these hips up to this time have shown any tendency to relapse into the external rotation—varus deformity—present in all cases of fracture of the hip. In this one case, in the fourth week, the roentgenogram showed a collapse of the posterior fracture area with an external rotation—varus relapse. However, the patient now has a painless stable hip with better function than the roentgenogram would lead one to expect. The follow-up roentgenographic examinations in all these cases demonstrated a varying degree of neck shortening, but no evidence of change from the stable weight-bearing relationship of the fragments attained at the time of reduction. The writer has been surprised at the absence, up to the present time at least, of any signs of arthritic changes in these hips. All of the patients have shown a remarkable recovery of balance and muscle tone; in fact, none of them has suffered any of the usual muscle atrophy and loss of knee function associated with the use of plaster or traction fixation.

## CRITERIA FOR END RESULTS

In evaluating end results, the writer believes that too much emphasis has been placed on the feature of apparent bony union. It is a well-known fact that, no matter what the method of treatment, a certain number of cases of hip fracture in all the age brackets have eventually progressed to a demonstrable solid bony trabeculation across the fracture area. However, it seems to the author that one could reasonably express a doubt as to the roentgenographic interpretations usually presented as a basis for the reports of a high percentage of cases of bony union resulting from this or that procedure. In the majority of the younger patients, with good reduction and internal fixation, bony union can be expected. This is confirmed roentgenographically after a sufficient length of time, by the areas of repair invasion of the head by new bone trabeculae from the neck in the manner suggested by Phemister. This favorable result will be obtained only if the fixation method has been effective in retaining the proper weight-bearing relationship of the fragments.

In the older patients, we probably must be satisfied with a satisfactory weight-bearing function, and perhaps assume that the fixation nail will be the chief factor in maintaining a useful leg for these patients during the rest of their lives. In other words, the writer would like to propose

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the Smith-Petersen trefoil nail. In the first four cases the fragments were speared with the wires. This is not a satisfactory method. The wires are inadequate mechanically, dangerously prone to wander into the pelvis, and, in the writer's opinion, should be abandoned. In the next eighteen cases the Moore multiple pins were used. This method has in our hands produced consistently good results. However, here again the method fails to satisfy completely the mechanical requirements. Only one of the three pins can be located in the cortex, neck, and head, so as to resist effectively the sheering strain of muscle pull and weight-bearing. While the combined surface areas of the three pins is approximately only 20

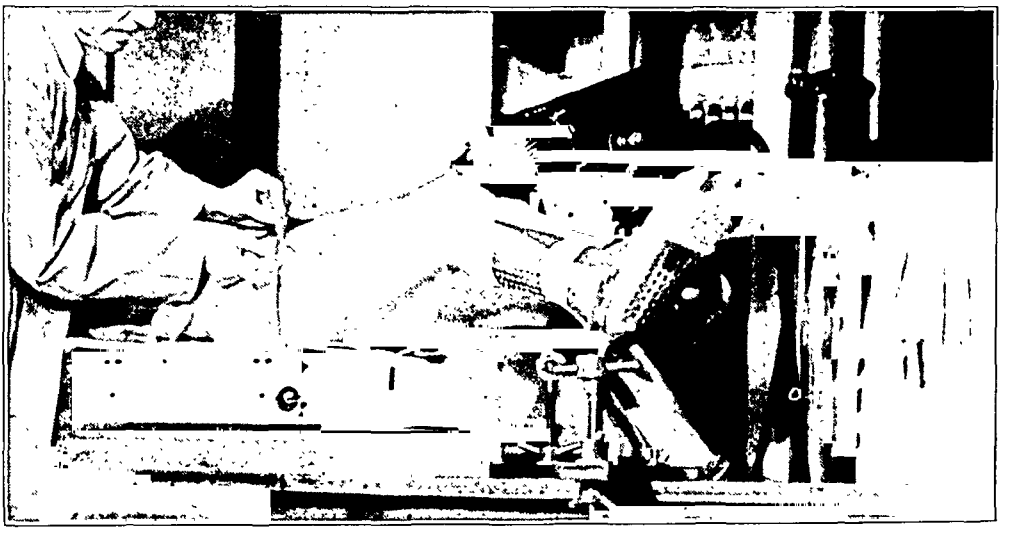


FIG. 1

Table device which makes possible the determination of the exact point of entrance of the nail, of its length, and of the angle of incidence to the shaft.



FIG. 2

Method of obtaining the lateral roentgenogram.

per cent. less than that of the usual trefoil nail, the area is so divided as to be much less efficient in all three of the mechanical factors,—namely, resistance to sheering strain, rotary movement of one fragment on the other, and, of less importance, any possible "draft" effect which the fastening might have. In all of the remaining cases of this series the trefoil nail has been employed.

It seems to the author that the Smith-Petersen nail as modified by Warren White meets in every way the requirements for this type of fixation instrument. Beautifully machined from completely corrosion-resistant chrome-nickel steel, its thin, sharp blades disturb a minimum amount of bone, while its flat surfaces and slightly more bulky head tend to anchor the nail fimly in the compact cancellous bone of the femoral head, as well as in the denser cortex of the shaft. The writer can see no advantage in the use of threaded screws or bolts, and certainly no metal that undergoes chemical corrosion or electrolysis should be inserted into these bones. Chrome-nickel steel of accepted formula is both corrosion-resistant and non-magnetic. Two of these nails were immersed in a solution corresponding to the physiological body fluids at body temperature, one under aerobic and the other under anaerobic conditions, for three months. After removal, neither nail showed even a suggestion of tarnish or of oxidation.

OPERATIVE TECHNIQUE

Following closely the procedures of Smith-Petersen, Johansson, and Wescott, we have, at the time of publication of this article, operated on forty-three fresh fractures of the neck of the femur in forty-two patients. In no instance has the hip joint been opened, internal fixation after reduction having been attained via the usual lateral thigh incision. The determination of

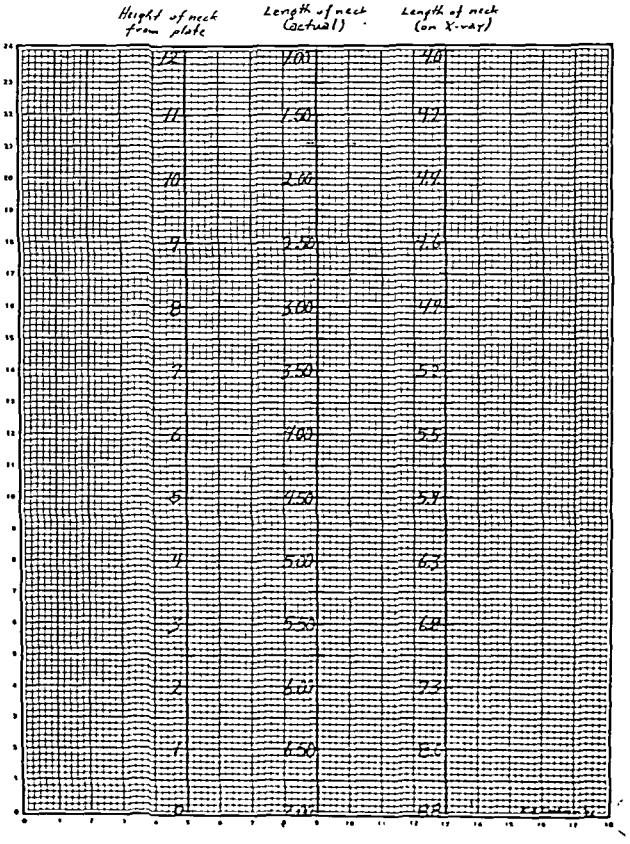



FIG. 3

Graph for calculating the actual neck length.

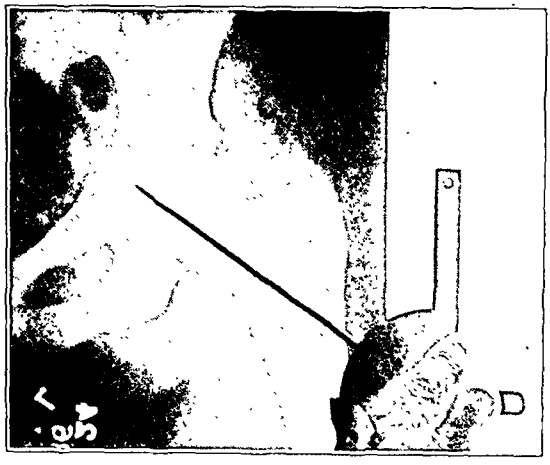


FIG. 4

Modification of Wescott's protractor by which, on the postreduction film, the angle for the proper nail location is read and the total length of cortex, neck, and head is determined.

the exact point of entrance of the nail, of its length, and of the angle of incidence to the shaft is made possible by the table device shown in Figure 1. With the patient already in position on the flat Bucky diaphragm, the fracture is reduced and the leg holder is adjusted to the leg in any position which seems proper. The usual leg position is the one shown in the illustration,—namely, moderate flexion and abduction and *full* internal rotation. In this way the injured leg remains constantly and rigidly fixed in relation to the top and edge of the Bucky diaphragm, so that anteroposterior and lateral roentgenograms of the neck of the femur will be exactly duplicated throughout the entire operation. In making the anteroposterior roentgenograms, the x-ray tube is always centered over the hip at exactly the same distance from the top of the Bucky diaphragm.

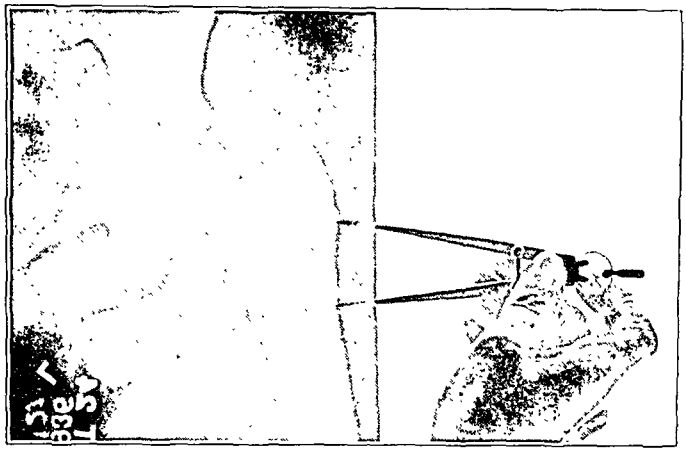


FIG. 5

Divider used to measure on the postreduction film the distance down the shaft from the ridge.

The lateral roentgenogram, shown in Figure 2, is made by aiming the tube at the femoral neck along an imaginary line called the pelvic line, from the lower edge of the symphysis pubis to the superior iliac spine, with the central beam of the tube inclined exactly 35 degrees below the horizontal. The cassette in its sterile cover rests on the top of the Bucky diaphragm with the edge pressed into the patient's flank and its surface at right angles to the pelvic line and inclined out against a light metal support, exactly 35 degrees from the vertical. At this time also a measurement is taken from the top of the table to the center of the mass of the femoral shaft as outlined by the thumb and forefinger (Fig. 1). By means of this measurement, the exact distance of the hip from the x-ray film can be computed for any given patient. It is called "hip height," it varies widely in different patients, and it is important if we are to compute accurately from the roentgenographic findings the actual distance from cortex to head in any given patient.

Assuming that the position is satisfactory, the postreduction films are now ready for use. By using a modification of Wescott's protractor with its base on the edge of the film (Fig. 4), certain data are obtainable. The angle for the proper nail location is read. The total length of cortex, neck, and head along this line is determined and noted. The distance down the shaft from the ridge is measured with a divider (Fig. 5). While these angles and distances are being noted, similar sterile instruments are being set and adjusted by the operating-room nurse.



FIG. 6

Small drill and dividers used to spot the entrance of the nail.



FIG. 7

A long, fairly stiff guide wire is drilled into the shaft, neck, and head. Note the adjustable stop located on the wire at the predetermined nail length from its entering tip.

To save time in calculating the actual neck length in the patient, which is a matter of arithmetical proportion, we have a prepared graph (Fig. 3) based on a constant height from tube center to film used in all cases. The left-hand column represents the height of the hip from the film. The right-hand column shows the length of the neck as measured on the roentgenogram. For example, if a straight edge is placed on *8* inches in the left-hand column and on the roentgenographic measurement, *6.3* inches in the right-hand column, it will cross the center line just above *4*, which will be the exact length in inches from shaft to head, and a nail, three and three-quarters inches in length, is indicated.



FIG. 8

Nail lying full length in the denser portions of the bone.

With the lateral aspect of the shaft



FIG. 10
Nail driven into neck.

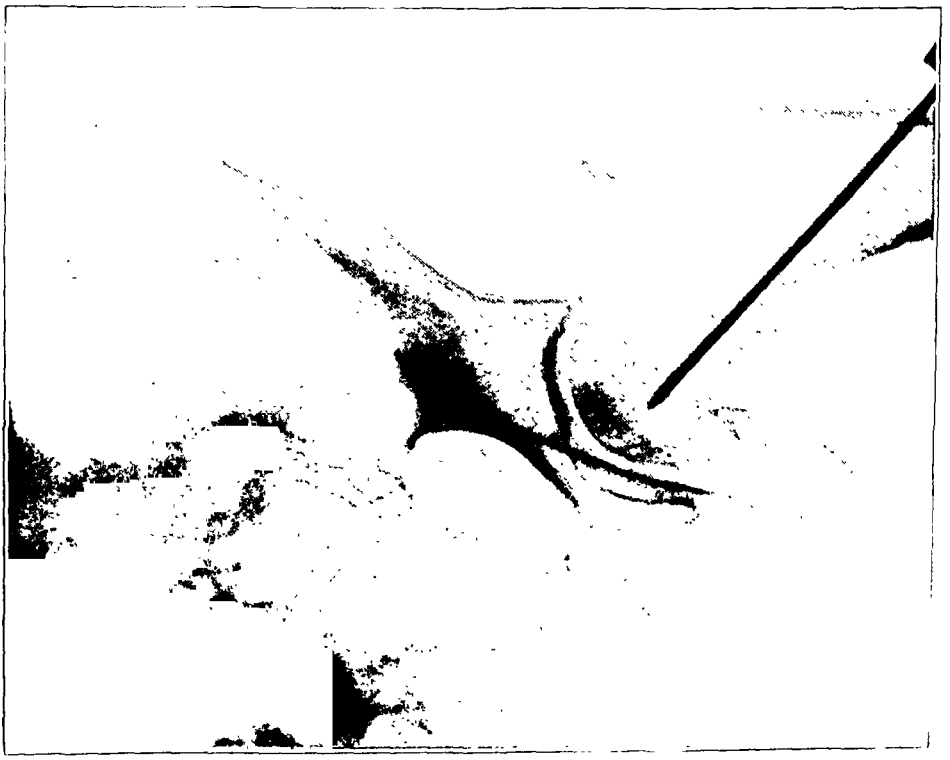


FIG. 9
Guide wire in place.

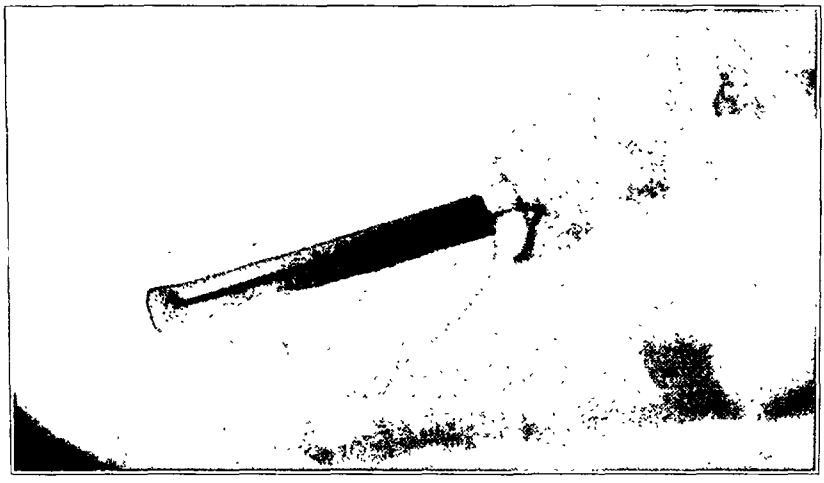


FIG. 11

Lateral roentgenogram to check the position of the nail.

exposed, the point of entrance of the nail is spotted with a small drill and the dividers as shown in Figure 6. With a protractor constructed to transfer the angle read from the roentgenogram to the operating table in a generally horizontal plane, a long, fairly stiff guide wire is drilled into the shaft, neck, and head. An adjustable stop is located on the wire at the predetermined nail length from its entering tip. (See Figure 7.) We try to keep the guide wire in contact with the inferior surface of the medullary canal of the neck in order to later place the nail so that its full length lies in the denser portions of the bone as shown in the specimen illustrated in Figure 8. If the Warren White instruments are used, the nail is easily and accurately driven

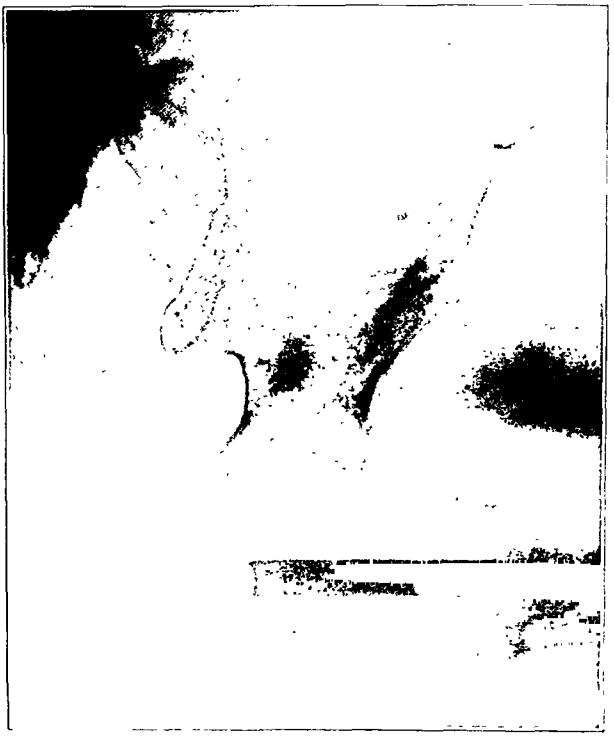


FIG. 12

Ninety-degree projection taken after the wound had been closed and dressed.



FIG. 13-A



FIG. 13-B

Roentgenograms of right and left hips taken in August 1937, showing in each case some shortening of the neck, but the weight-bearing relation of the head is good.

parallel to the guide wire and at such inclination to the horizontal surface of the table as has been determined by the first lateral roentgenogram taken.

Figures 9 and 10 show the guide wire in place and the nail driven. Figure 11 is a lateral roentgenogram to check the position of the nail. Finally, after the wound has been closed and dressed, the thigh is flexed at a right angle and the 90-degree projection shown in Figure 12 is made if desired.

While the procedure described may sound complicated, it is really very simple. No novelty is claimed for any part of it, with the possible exception of the table and x-ray combination, and here our only point is that, with fixed and rigid relations of leg to roentgenographic-projection distances and angles, it becomes possible to insert and to drive the right sized nail at the proper location with complete confidence and assurance that the nail will not go astray. The whole procedure takes from fifty to seventy minutes from the time the patient is placed on the table. This includes reduction, the taking of the three sets of two films each to check reduction, the insertion of the guide wire and nail, and of course the actual operating time which is really quite brief.

The roentgenograms shown in Figures 13-A and 13-B are interesting and were made late in August 1937. The patient, aged seventy-eight, was operated upon early in March 1937, and a fracture of the left hip was re-

duced and the fragments were nailed. In July she was walking comfortably with a good functional left hip, when she fell over a rug fracturing the right femoral neck. An operation was performed on this hip and the fragments were nailed. Both femoral necks show some shortening, but the weight-bearing relation of the head remains good. The patient is apparently once more on her way to obtaining useful and comfortable function of both hips.

## CONCLUSIONS

1. Internal fixation of fresh fractures of the femoral neck has been demonstrated by the work of many surgeons to be a justifiable and reliable method of treatment for this important and serious injury.

2. Internal fixation of these fractures can be accurately and successfully accomplished without the added hazards of a hip-joint arthrotomy.

3. This procedure should not be classified as a simple and casual operation to be done under any and all conditions. However, judged on the merits of reported results from many clinics, this plan of treating hip fractures is worth all it costs in the way of expensive and special equipment and deserves the thoughtful consideration of all surgeons charged with the care of these cases.

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# CLOSED REDUCTION OF FRACTURES OF THE NECK OF THE FEMUR*

BY GUY W. LEADBETTER, M.D., WASHINGTON, D. C.

In the treatment of intracapsular fractures of the neck of the femur, the efficacy of any single procedure depends on the skill of the individual surgeon, his judgment, his experience with the type of fracture at hand, and the general condition of the patient with particular reference to his recuperative powers and to no small extent to his mental cooperation. The cardiovascular-renal system should be examined carefully for any organic disease or decompensation. Dehydration, when present in the elderly patient, should always be recognized and treated before any attempt to correct the injury is made. Intestinal stasis is an important element to be considered, especially in the patient of advanced years.

At the present time two general types of procedure are widely used by qualified fracture surgeons. One school of thought advocates closed reduction and plaster fixation; the other chooses closed reduction with some form of internal fixation, the Smith-Petersen nail being used by the majority, although the three-pin internal fixation has been reported to have yielded excellent results. The technique, however, of both of these operations is essentially the same.

The end results of the treatment in the past are shown in Table I.

The author wishes to report a series of eighty-one cases treated for fracture of the neck of the femur. Fifty-nine of these were followed accurately. The ages of these fifty-nine patients ranged from forty to ninety-two years, and the period of observation extended from one to nine years. All of the patients were treated by closed reduction and skin-coaptation plaster fixation. Good union resulted in 71.18 per cent.; good function but no bony union in 6.79 per cent.; failure in 13.57 per cent.; and death in 8.46 per cent. Thus 22.03 per cent. of the cases resulted in failure. The average time in plaster was ten weeks. The average time of recumbency was twelve weeks. Full weight-bearing was not allowed for six months.

These results are apparently commensurate with those reported in other recent series and seem to represent about all that may be expected from this particular procedure, although ambulatory treatment such as that suggested by Kleinberg may offer a higher percentage of good end results. There is considerable ingenuity in this procedure and we should not be too hasty in condemning such technique.

Meticulous attention to the proper and anatomically accurate reduction of the fragments is certainly the first step in any procedure. To be satisfied with even an approximate reduction is not sufficient, statements

*Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 2, 1937.

TABLE I

END RESULTS OF CLOSED REDUCTION OF FRACTURES OF THE NECK OF THE FEMUR

| Date Reported | Author | Method | No. of Cases | Bony Union (*Percentage of Cases*) |
|---|---|---|---|---|
| 1913 | British Fracture Commission | Conservative | | 13.8† |
| 1913 | British Fracture Commission | Conservative | | 22.0 |
| 1914 | Walker | Conservative | 112 | 13.0 |
| 1923 | Campbell | Abduction | 21 | 75.0 |
| 1923 | Campbell | Tibial graft | 12 | 58.3 |
| 1928 | Katzenstein | Conservative | 119 | 11.5 |
| 1929 | Albee | Tibial graft | 39 | 97.4 |
| 1930 | Fracture Commission of the American Orthopaedic Association | Abduction | 210 | 53.8 |
| 1930 | Reggio (Records from the Massachusetts General Hospital) | Abduction | 49 | 49.1 |
| 1931 | Smith-Petersen | Nail | 20 | 75.0 |
| 1931 | Stern | Abduction | 15 | 87.0 |
| 1932 | Campbell | Abduction | 75 | 53.3 |
| 1934 | Henderson | Abduction | 36 | 66.6* |
| 1934 | Henderson | Bone graft | 53 | 69.8* |
| 1935 | Moore | Three pins | 20 | 85.0** |
| 1935 | Dickson | Abduction | 68 | 70.0 |
| 1935 | Dickson (from two clinics) | Nail | 31 | 83.3 |
| 1935 | Dickson (from his own clinic) | Nail | 9 | 77.0 |
| 1936 | Krida | Tibial graft | 6 | 66.6*** |
| 1936 | Henderson | Nail | 7 | 100.0 |
| 1937 | Moore | Three nails | 24 | 96.0 |

† Patients over sixty years of age.
* Not counting two deaths.
** Counting three patients who died.
*** Counting two patients who died.

to the contrary notwithstanding, no matter what the method of fixation may be. It has been conclusively shown that these fractures can be reduced by careful manipulation.

For the sake of clarity, it seems wise to reiterate the steps in reduction and fixation described in the paper read by the author at the meeting of the American Orthopaedic Association in Toronto in 1932. The injured leg is flexed at the hip at 90 degrees. Manual traction is applied in the axis of the flexed thigh, together with slight adduction of the femoral shaft. In this position the thigh is internally rotated, and the leg is slowly circumducted into abduction, the internally rotated position being maintained. As the leg is brought down to the table level, the heel-palm test should be applied to confirm position. The amount of measured abduction is determined by inspection of the roentgenograms taken previous to the manipulation, and the angle of the uninjured side is compared with that of the fractured side. The difference in degrees between the two angles is roughly the amount of abduction required. It can be still more accurately determined and verified by applying the heel-palm test which allows only a few degrees' variation in abduction or adduction before change in the position of the leg takes place,—for example, if the leg is carried too far toward the adduction side, it will slowly evert itself in the palm of the hand and give evidence of disengagement of the fragments. If abduction is forced beyond the normal limits necessary to maintain coaptation of the fragments, then greatly increased tension of the adductor muscles will be felt and there will be a tendency for the knee to flex slightly. This has been found to be a very satisfactory method of determining the amount of abduction in the reduced fracture. The leg is then held by an assistant without traction, and the plaster is applied as follows. A one-layer thickness of glazed cotton is placed about the torso from the nipple line over the affected hip to a point about half-way between the hip and the knee. Then a long strip of felt, one-half an inch thick, is placed about the pelvis, extending from just above the iliac crests to the trochanters, and completely encircling the pelvis. This is all the padding necessary and allows very tight application of the plaster. The body portion is first applied as tightly as possible, snug coaptation being the aim. Firm pressure over the injured hip is necessary. Below the hip no padding is applied. Two plaster slabs, molded carefully to the contour of the leg, are bandaged closely to the skin, one posteriorly and one anteriorly. Padding is placed beneath the heel, and the plaster is molded well and coapted snugly. Circular plaster is applied around the two molded leg splints. Care is taken to carry the cast high under the pubis and the ischium with sufficient felt padding which is cut very closely in the trimming of the cast. The U is then cut from the body segment of the cast anteriorly, leaving the sides high in order to prevent the patient from swinging to the opposite side, thereby changing the relative position of body and leg. Extreme abduction is rarely necessary. It is quite clear that the valgus position is best. Only in rare cases does full

abduction allow such valgus position. It has been the author's experience that by far the majority of cases demand very little abduction.

Several men have indicated that they change the plaster after three weeks. This is to be commended, especially in handling stout individuals. We all experience the problem of the loose cast in such patients Fixation is less secure, although the skin-coapted plaster diminishes the chance of slipping. The necessity for change may be determined by frequent inspection of the cast. Roentgenograms taken immediately after application of the cast and at intervals of two weeks show change of position of the fragments If malposition is noted without absorption of the neck, reduction should again be done and the case treated as before.

During the active convalescent period it has been our custom to put the patient in the erect position as soon as possible, permitting him to walk without a caliper brace but with crutches. While no weight-bearing is allowed, he is painstakingly taught to walk with regular rhythm of gait, touching the foot of the injured leg to the floor but not applying any force. In this way an early regulation of gait is established. There is a fairly rapid improvement in the tone of the muscles of the hip and the leg, and it is not so difficult, when the time comes, to wean the individual from crutches. Two canes are first substituted and these are rapidly followed by one. The discarding of the last cane is left largely to the patient's discretion.

As shown by the reported results in the last eight years, the efficiency of treating these fractures has increased. We should bear in mind that probably no single method is adaptable to all cases and to all localities. A recent questionnaire which the author sent to orthopaedic surgeons, to general surgeons, and to general practitioners in all sections of the country revealed some interesting figures. They grouped themselves very sharply into two units. The agreement of estimated figures in these units was striking.

In the cities of 20,000 population and over, it was found that an average of 71.18 per cent. of the cases were treated by the orthopaedic surgeons, 23.5 per cent. by the general surgeons, and 5.5 per cent. by the general practitioners. The procedure employed was chiefly plaster application with the abduction treatment and internal fixation. Practically no cases of actual open reduction were reported.

In cities and towns of 20,000 population and under in the rural districts, an average of 39.9 per cent. of the fractures of the neck of the femur were treated by the orthopaedic surgeons, 46.1 per cent. by the general surgeons, and 14.1 per cent. by the general practitioners. Here the treatment varied widely from sand-bags to suspension traction, the Roger Anderson splint, plaster, and only occasionally internal fixation.

These figures present an argument in favor of teaching two methods,—namely, closed reduction with plaster cast and closed reduction with internal fixation.

We cannot know what dire results may present themselves if those

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unskilled in the technique of internal fixation attempt such treatment, and, until we are able to educate the profession and the laity in general to the fact that internal fixation is a technical procedure, it is the author's feeling that we should continue to teach the old method as well as the new.

These two procedures are truly a fine armamentarium and, as in other fractures, the writer feels that we should apply the rule of conservatism whenever reasonably possible and utilize internal fixation when in our judgment it is necessary. In the last year and one-half we have applied this rule with what appears at the present time to be very satisfactory results, although the cases have not been followed long enough to state so definitely. We have nailed approximately 75 per cent. of the fresh fractures and in the remainder have applied the plaster-fixation method.

In selecting the cases, the patient's age, his general physical condition, his muscular condition, and, to no small extent, his choice (some patients object to nailing) must be considered.

It is not by one single stereotyped form of treatment that the problem of the fractured hip will be solved. Both plaster fixation and internal fixation should be taught. Open reduction is not necessary, but, in the final analysis, it cannot be denied that internal fixation is more adequate than plaster, and that early mobilization of the individual is most important in preventing chronic disability in the aged. Plaster fixation cannot be expected to yield good results consistently and logically in more than 65 or 75 per cent. of the cases.

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fractures of the neck of the femur), but they can be recognized by certain signs: (1) a relatively slight deformity, especially a small amount of shortening; (2) the relatively slight amount of pain; (3) the ability of the patient to move the leg voluntarily, at least to some degree; (4) occasionally the ability of the patient to walk on the leg.

Whitman's abduction method of treatment marked a great advance solidly based on sound principles, but it has its shortcomings, as is evidenced by the percentage of failures to secure bony union. This is due to the inability always to secure perfect fixation of the fragments, even by the use of abduction and a plaster spica. A very brief experience with the plaster spica will convince one of the impossibility of keeping the hip joint completely at rest. So much soft tissue is interposed between the plaster and the joint that the patient can move within the plaster, and complete immobility of the fracture line is rarely attained. Further, if the knee joint is freed for exercise during the period of plaster fixation, the pull on the quadriceps, from its origin on the ilium to its insertion in the patella, exerts a force which pushes the shaft of the femur upward and sheers across the line of fracture, completely disturbing the absolute fixation of the fracture which is essential for union. It is this fact which makes reduction with the head in valgus and the Schanz osteotomy valuable adjuncts of treatment. They alter the relationship between the line of fracture and the forces playing upon it, so that the latter are expended in forcing the fractured surfaces together instead of sheering one across the other. The great contribution which has been made by internal fixation of fractures is that it secures adequate fixation of the fracture line and simulates the situation which exists in impacted fractures.

In the past three years the Fracture Service of the Toronto General Hospital has treated fifty cases of intracapsular fracture of the neck of the femur by internal fixation. The Smith-Petersen nail is the only form of internal fixation which we have used. It has been introduced by various methods, chief among which are: open reduction, as practised by Watson Jones; insertion along a previously placed Kirschner wire, as advocated by Johansson; and the use of a long handle screwed into the nail, as recommended by White. Broadly speaking, our results have been eminently satisfactory. We have encountered some difficulties and some failures. The latter have been due to technical problems which will be discussed later. Our experience leads us to the conclusion that, after satisfactory reduction of a fracture, a Smith-Petersen nail properly placed in the fragments can be counted upon to secure bony union in every case. In addition, the method permits the satisfactory treatment of certain other difficult problems, such as ununited fractures of the neck of the femur, in a manner not hitherto possible.

So impressed are we with the value of the method that we believe we may accept its success as proved. More is to be gained by discussing difficulties and imperfections which lead to poor results.

# EXPERIENCES WITH INTERNAL FIXATION IN FRESH FRACTURES OF THE NECK OF THE FEMUR *

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During the past three years, on the Fracture Service of the Toronto General Hospital, we have been treating fractures of the neck of the femur by internal fixation, and, in general, our experience has been such as to make us enthusiastic advocates of this method. Two years ago Dr. Kellogg Speed referred to this fracture as "The Unsolved Fracture". Today that opprobrium is almost completely removed, due to the great advance in the treatment of this difficult surgical problem by means of internal fixation. The method is based on sound principles and, although there may be a number of technical problems yet to be solved, the importance of the contribution is established, and, in our judgment, it will govern the future treatment of these fractures.

This paper is based upon our experience. It is concerned chiefly with certain difficulties which we have encountered, and it is presented with the hope that frank discussion of such difficulties may lead to further simplification of methods and improvement in results.

The principle on which the success of the method is based is a simple one, although before the introduction of the Smith-Petersen nail it was not clearly recognized. It is this: in a fracture of the neck of the femur, as in any other fracture, the fragments will unite if (1) the fracture is accurately reduced, (2) the fragments are placed in close contact with one another, and (3) the fragments are *maintained* in contact with each other *without any movement whatsoever* during the whole period of healing. The last requirement is of incomparably greater importance than the other two. If these requirements are attained, union will take place irrespective of the problem of the blood supply of the head of the femur. Even though the femoral head is deprived completely of its blood supply and undergoes complete aseptic necrosis, union will still take place if contact without movement is rigidly maintained. A graphic illustration of these principles is the observation that truly impacted fractures of the neck of the femur will always unite provided the impaction is allowed to remain undisturbed. So important is this observation that it has come to be our practice to leave impacted fractures undisturbed, as we feel that the certainty of union in 100 per cent. of cases greatly offsets the disadvantages of any minor degree of deformity (usually external rotation). Truly impacted fractures are rare (comprising not more than 10 per cent. of all cases of intracapsular

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 2, 1937.

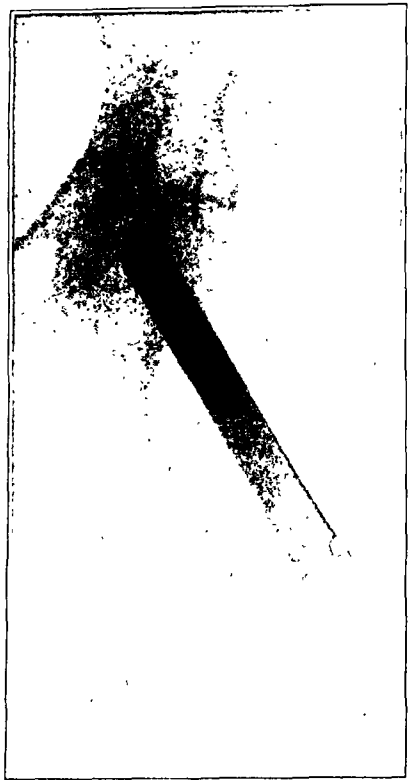


FIG. 2-A

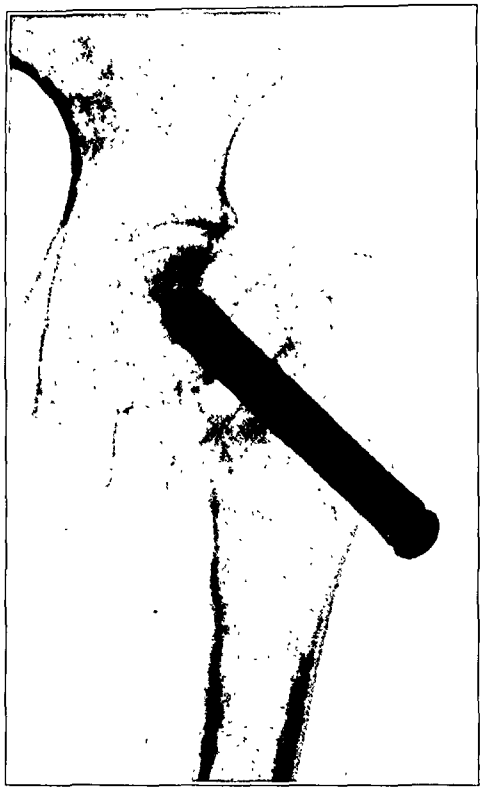


FIG. 2-B



FIG. 2-C

Imperfect result from too early weight-bearing (three weeks after operation).

Fig. 2-A: Good reduction and good position of nail at time of operation.

Fig. 2-B: Three months after operation. The head has shifted downward from too early weight-bearing; the neck is absorbed; the angle of the nail is changed; and the nail has been pushed out backward through the trochanter.

Fig. 2-C: Further settling downward of the head on the neck and further protrusion backward of the nail. Union took place in this position.

## THE IMPORTANCE OF GOOD ROENTGENOGRAMS

Our experience would indicate that certain factors are of vital importance in the success of the procedure. It cannot be too strongly emphasized that the insertion of the nail is a highly technical procedure, only to be undertaken in adequately equipped hospitals and with a perfect coordination between the X-Ray Department and the operating-room staff. This indeed is one of the greatest shortcomings of the method. It can be undertaken only in the larger hospitals, and hence a large number of patients in rural communities are deprived of the benefits of the procedure. Good roentgenograms are essential to success. In the past we have had difficulty in obtaining uniformly good x-rays, especially in the supero-inferior direction. Some of our failures, or imperfect results, have been due to this cause. It is quite possible to accept as good enough the position of the nail on the evidence of a poor supero-inferior roentgenogram, only to find after a lapse of months that the nail has an imperfect grasp on the head or has deviated from the central line of the neck, or has penetrated the head posteriorly or anteriorly and is impinging on the acetabulum. This fault can be eliminated by good supero-inferior x-rays. Such should be insisted upon, no matter how much it delays the operation. (See Figures 1-A and 1-B.) The essential features with which the X-Ray

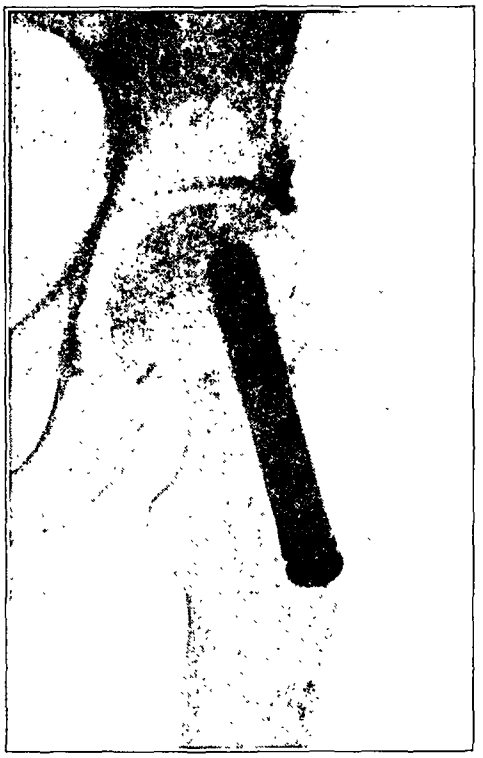


FIG. 1-A



FIG. 1-B

Imperfect result due to protrusion of the nail through the anterior surface of the head into the acetabulum, the result of poor roentgenograms.

Fig. 1-A: Anteroposterior view at time of operation. Lateral view taken at this time was poor, but seemed to show satisfactory position of the nail.

Fig. 1-B: Lateral view eight months after operation, revealing the cause of the patient's pain on weight-bearing and walking. The fragments united in fair position; there was moderate limitation of movement, due to arthritis. The nail was removed.

However, experience with two cases (Figs. 2-A, 2-B, 2-C, 3-A, and 3-B) convinces us that too early weight-bearing can ruin an otherwise perfect operation. We have, therefore, adopted the routine of keeping the patient in bed for eight weeks following operation. It may be that in certain cases even this period of time is too short for solid union to occur and that we should wait for roentgenographic evidences of bony union even though to do so would preclude weight-bearing for six months. Among surgeons of our acquaintance there is the greatest diversity of practice in regard to the time in which weight-bearing is permitted. This phase of treatment we feel is not yet quite solved. Longer experience will be necessary before definite rules can be laid down. Our first impression was that an important advantage in the use of the Smith-Petersen nail was the possibility that the patient might walk within a month of the time of fracture. It is true that early weight-bearing can sometimes be permitted without bad results. This is to be attributed to the rigidity with which the nail fixes the fragments, and does not alter the indisputable fact that great strain is placed upon the point of mechanical fixation. Any imperfection in this fixation will permit movement and mar the results. The difference between a perfect result and an imperfect one or a failure is so great that eight weeks spent in bed is a small price to pay for it. If at the end of an arbitrary period of time, such as eight weeks, any doubt of union exists, weight-bearing should not be permitted until roentgenographic evidence of union is present.

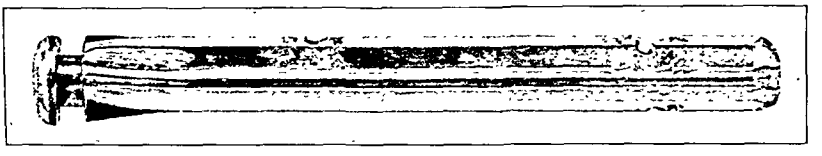


FIG. 4

Smith-Petersen nail of high-chromium, high-nickel, stainless steel but not polished. Marked corrosion necessitated removal of nail, although not until union had occurred.

### THE IMPORTANCE OF USING NAILS MADE FROM PROPER STEEL

A third source of difficulty has been but little stressed. This is the quality of the steel which is used for the nails. It is essential that the nail be as completely non-irritating as possible. In order to perform its function, it must stay in place at least for several months. Should any infection or irritation occur during that time, the close association with the hip can lead to disastrous destruction of the joint. (See Figure 4.)

Stainless steel is a generic term used to designate any alloy of steel which resists corrosion, but especially those containing nickel and chromium. There is a very wide variety of these alloys,—they vary in their content of nickel and chromium, in their ability to resist oxidation, in their hardness or softness, and in their ability to be tempered. It should be emphatically stated that not all stainless steels are suitable for use in

Department must be able to provide the surgeon to ensure success are: (1) a portable x-ray machine of adequate power; (2) a technique which will give good views of the fracture in two planes—supero-inferior being particularly important—and permit successive sets of roentgenograms to be compared with each other (this means taking each film from a predetermined position of tube and cassette); (3) developing facilities within easy reach of the operating room, so that the developed films may be seen quickly.

### THE DANGER OF BEARING WEIGHT TOO EARLY

The second source of failure is too early weight-bearing. There have been one complete and one partial failure in our series from this cause. It is remarkable how securely the nail will fasten the fragments together. Nevertheless, to bear weight upon the limb before solid union has occurred places a great strain upon the fracture line, and this can cause the head of the femur to be torn off the end of the nail or to shift its position. A striking example of the security of fixation obtained by the nail occurred in a mentally deranged woman in whom a fractured neck of the femur had been treated by insertion of a Smith-Petersen nail. She got out of bed on the second day after operation and from that time on was out of bed walking during some part of every day. Three months after operation she secured a position as housekeeper and has been able to walk ever since. No shift occurred in the fragments and solid union was secured.

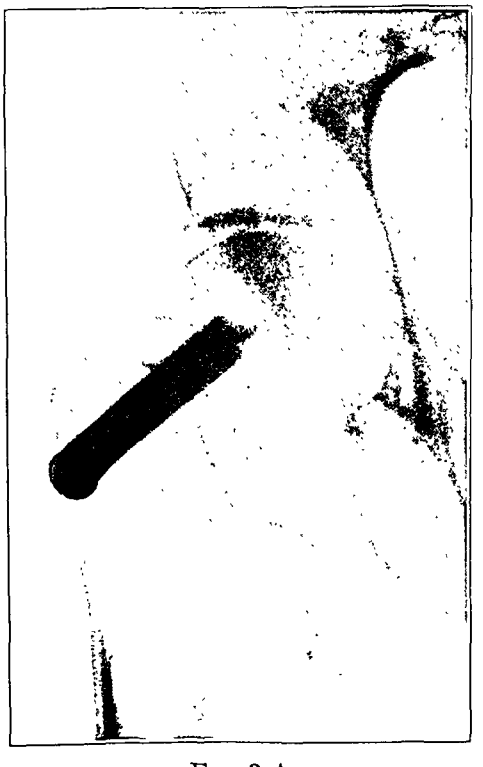


FIG. 3-A

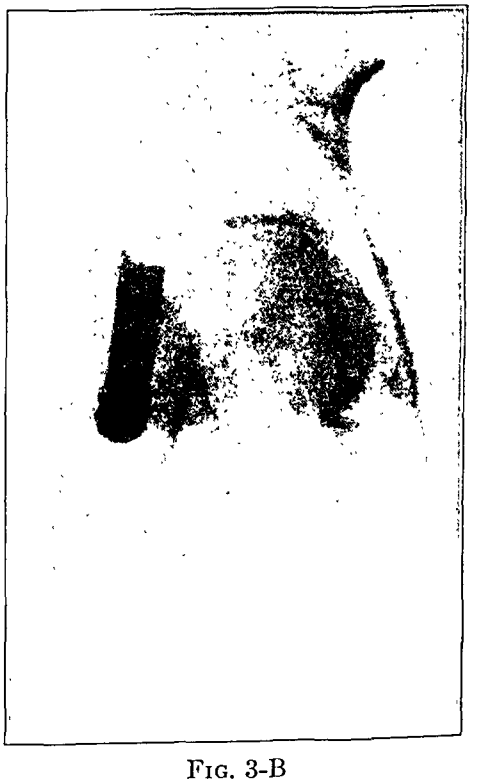


FIG. 3-B

Complete failure from too early weight-bearing (one week after operation).
Fig. 3-A: Immediately after operation.
Fig. 3-B: One month after operation. Complete separation of head from neck and from nail.

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FIG. 5-A

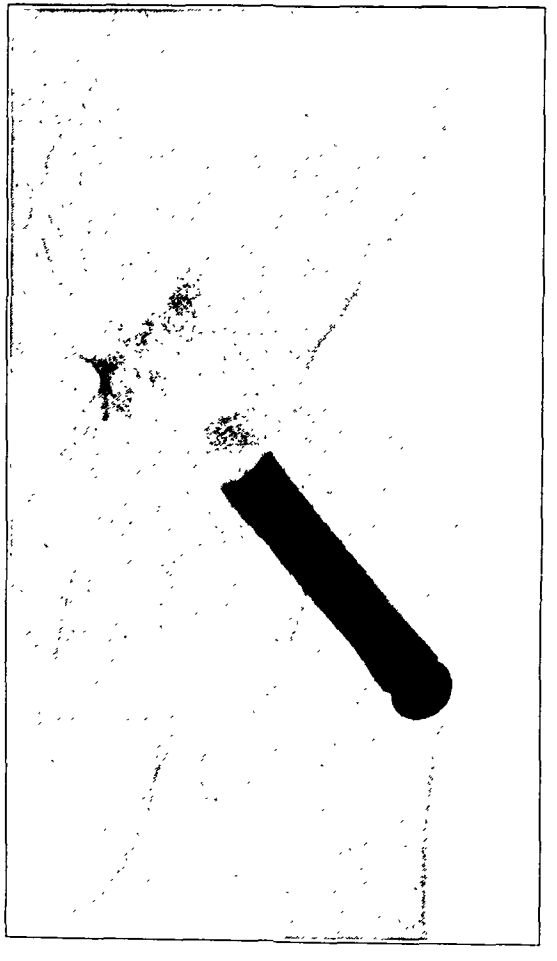


FIG. 5-B

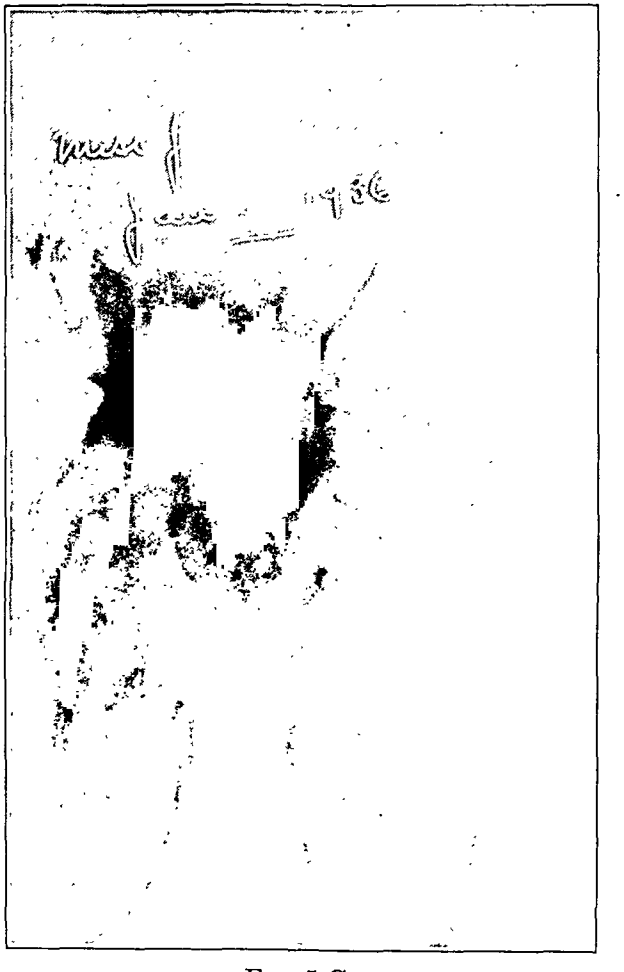


FIG. 5-C

Infection of hip joint, the result of reaction to nail.

Fig. 5-A: Ununited fracture of six months' duration; fragments well secured by Smith-Petersen nail.

Fig. 5-B: Eight months after operation. Reaction about nail resulted in sterile abscess which burst spontaneously through wound. Nail left in place because of necessity for prolonged fixation. Secondary infection of sinus occurred with invasion of hip joint, destruction of cartilage, and upward wandering of acetabulum.

Fig. 5-C: Ten months after operation; nail removed. Union has occurred, but hip joint is grossly damaged.

bone work. The mere fact that a certain alloy of steel will resist corrosion or exposure to air is no proof that corrosion will not take place when the nail is inserted in bone. The so-called high-nickel, high-chromium alloy has proved least irritating and least corrodible.

A further point of great importance is the manner in which the nail is finished, irrespective of the material from which it is made. It has been proved from the researches of Hatfield that the ability of stainless steel to resist corrosion is due to the presence of a film of chromium oxide on the surface of the steel. The smoother the surface of the steel, the more perfect will be this film and the greater the powers of resistance to corrosion. Any imperfection or irregularity on the surface may break the film and permit corrosion to start. Hence, not only should Smith-Petersen nails be made of high-nickel, high-chromium steel, but they should be finished with a high polish. This is a point of some importance, since even a small area of corrosion may set up sufficient irritation to necessitate removal of the nail.



FIG. 6

Imperfect result from an overlength nail inserted through head into acetabulum. Painful movement necessitated removal one year after operation. Good union and good position.

### THE DANGER OF USING NAILS THAT ARE TOO LONG OR OF DRIVING THEM IN TOO FAR

We have encountered difficulty occasionally by inserting a nail completely through the head of the femur, either because an overlength nail was used or because it was driven in too far. This problem is comparatively simple to solve, but it does stress the importance of choosing a nail of the correct length. In both cases in which this complication occurred the nail was subsequently removed, because of pain on movement. (See Figures 5-A, 5-B, and 5-C.)

### THE VALUE OF SIMPLIFIED METHODS

The greatest shortcoming of the method, however, is the highly technical nature of the procedure necessary to introduce the nail. Smith-Petersen's original technique was of such magnitude that most surgeons

TABLE I

RESULTS OF INTERNAL FIXATION BY SMITH-PETERSEN NAIL IN FIFTY CASES OF FRACTURE OF THE NECK OF THE FEMUR TREATED AT THE TORONTO HOSPITAL

| Result | No. of Cases | Per Cent. |
|---|---|---|
| Good:<br>Solid union and good function | 36 | 72.00* |
| Imperfect:<br>Solid union, but poor function<br>Nail too long in both cases | 2 | 4.00 |
| Failure:<br>Sepsis—1 case<br>Too early weight-bearing—4 cases<br>Pin inaccurately placed—2 cases | 7 | 14.00 |
| Death:<br>Sepsis in wound—1 case<br>Pulmonary embolus—3 cases<br>Cardiac failure—1 case | 5 | 10.00 |

* Good results were obtained in 80 per cent. of the surviving patients.

hesitated to use it on elderly patients who were poor risks. The great stimulus to the use of internal fixation came with the introduction of simpler and less traumatizing methods, especially that of Johansson. Even this and the further modifications of Watson Jones, White, and others still demand such a high degree of technical skill and perfection of equipment that the application of the method is limited. It cannot be undertaken except in hospitals which have adequate equipment, and relatively few have the desired armamentarium. It demands perfect coordination between a skilled X-Ray Department and the operating-room staff. The equipment and facilities of smaller hospitals are apt to be inadequate and, therefore, preclude the surgeon from operating "out of town", and the patients will not stand transportation for long distances. Finally, it can only be done with success by a surgeon who is thoroughly familiar with bone surgery and the surgery of the hip joint; it emphatically is not an operation to be performed by the occasional surgeon, or the general surgeon, or, indeed, by anyone not skilled in orthopaedic surgery. These factors greatly limit its application. It is most desirable to achieve further simplification of the method of introducing the nail, so that the method can be more widely applied. Until then, we should not abandon the simpler and more widely applicable abduction treatment of Whitman.

## COMMENT

It only remains to be stated that nearly all our failures occurred in the early period of our use of this form of treatment. Further experience has

enabled us to insert the nail with increased speed and facility and with greatly diminished disturbance to the patient. Our experience leads us to believe that, after satisfactory reduction of a fracture, a nail properly placed in the fragments will ensure union in practically every case in greatly diminished time and with great improvement in function. Internal fixation of fracture of the neck of the femur marks a great advance in treatment. Our present attitude is that all fractures of the neck of the femur can best be treated by internal fixation.

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SPEED, KELLOGG: The Unsolved Fracture. Surg. Gynec. Obstet., LX, 341, 1935.

# DASHBOARD DISLOCATION OF THE HIP

## A Report of Twenty Cases of Traumatic Dislocation *

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The name "dashboard" dislocation of the hip has been chosen because it points out the means by which most of the patients upon whose cases this paper is based received their injuries. The person so injured was usually sitting beside the driver of an automobile when it came to an abrupt stop in a collision. In such a case, since the hip is in a flexed and adducted position, the force of the impact of the tibia or of the knee against the panel is transmitted through the femur to the posterior rim of the acetabulum, and the result may be a simple dislocation or a dislocation with fracture of the lip of the acetabulum. Occasionally a fracture of the tibia or of the patella is experienced instead.

This mechanism was the cause of dislocation in thirteen of the twenty cases here reported. In the remaining seven, two patients were thrown out of automobiles; two were struck by automobiles; one patient fell from a tree; one fell from a box car; and one was injured at birth.

The routine method of treatment in the fresh cases was immediate closed reduction, followed by traction of the Russell or Buck type. If there was a formidable fracture of the acetabulum, the traction was maintained for a period of approximately eight weeks. If, however, no acetabular fracture existed, the period of traction lasted only from two to three weeks. During the period of traction in both instances, active motion was maintained in the knee and the hip joints.

Treatment of the old cases required much more active correction, and the results were discouraging, as shown in Table I.

A brief description of these twenty cases is contained in Table I. The findings may be summarized as follows:

1. The age range of the majority of these patients was between twenty-three and fifty years.
2. There were thirteen males and seven females.
3. Thirteen of the patients were injured while they were riding as passengers in automobiles; in ten of these cases the right hip was dislocated.
4. The average period of observation was three years.
5. In the three cases in which operations were performed the average period between injury and treatment was eight months.

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 3, 1937.

6. In eleven cases the end results were good; in two, fair; in five (including the three cases in which operations were performed), poor; and in two, undetermined.

7. In six cases there was absorption of the head.

8. In seven cases there was an uncomplicated posterior dislocation; in one, an uncomplicated obturator dislocation; in one, an obturator dislocation with an incomplete fracture of the neck; in two, fracture of the neck and posterior dislocation; and in nine, posterior dislocation complicated by fracture of the acetabulum.

## COMMENT

The following case is typical of the injury under discussion and shows the result when treatment is delayed.

CASE 15. R. S., a boy, aged thirteen, was riding beside the driver of a roadster when the car hit an abutment and overturned. After a brief period of confusion, he got up and hobbled to another car. When he reached his home, the family physician was called. There was evidence of contusion about the right hip, but no shortening or apparent deformity. No roentgenographic examination was made at the time. The boy continued to complain of pain and swelling in the region of the hip, and three weeks after the injury a roentgenogram showed a complete posterior dislocation of the head of the femur (epiphyseal separation), but the neck had sprung back into the acetabulum. Because of the boy's age, an open reduction was done and, after much difficulty, the head was replaced on the neck and then put back into the acetabulum. The head was maintained in its position by means of an ivory peg. Aseptic necrosis of the head took place. Observation five years after injury (Fig. 1) showed shortening of one and one-quarter inches. The ability to abduct and to rotate was greatly limited. However, in spite of the limp, the boy was free from pain and took part in such athletics as tennis and golf.

Two similar cases (Cases 2 and 19) were treated more recently, with poor results. (See Figures 2, 3, 4, 5, and 6.)

Miltner and Wan reported a series of sixteen cases of hip dislocation of long standing in which reduction was accomplished in twelve with a fair percentage of good results. The anterior incision of Smith-Petersen was used in all but one case. However, our experience has caused



FIG. 1

Case 15. Epiphyseal-separation dislocation, five years after open reduction, showing neck in acetabulum.

TABLE I

TWENTY CASES OF TRAUMATIC DISLOCATION OF THE HIP

| Case | Sex | Age (*Years*) | Type of Dislocation | | Side Dislocated | Cause | Method of Reduction | | Time Between Injury and Treatment | Result | Period of Observation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Simple | Complication | | | Closed | Open | | | |
| 1. W. B. | Female | 28 | Posterior | | Right | Riding in car | Immediate. Traction for 6 weeks. | | 2 hours | Good | 2½ years |
| 2. W. C. | Female | 43 | Posterior | Fracture, with femoral neck in acetabulum | Right | Riding in car | Traction for 2 weeks. Cast for 10 weeks. | | 4 hours | Poor. Aseptic necrosis. | 10 months. Motion fair. Shortening of ⅞ of an inch. |
| 3. C. A. | Female | 27 | Posterior | | Left | Riding in car | Immediate. Traction for 2 weeks. Cast for 4 weeks. | | 2 hours | Good | 9 months |
| 4. D. W. | Male | 29 | Posterior | Slight fracture of acetabulum | Right | Riding in car | Immediate. Traction for 6 weeks. | | 24 hours | Good | 1 year |
| 5. M. G. | Female | 54 | Posterior | Fracture of acetabulum | Right | Riding in car | Immediate. Cast for 7 weeks. | | 5 hours | Good | 3 years |
| 6. J. M. | Male | 45 | Posterior | | Left | Riding in car | Immediate. Traction for 3 weeks. | | 3 hours | Good | 4 months |
| 7. H. C. | Female | 39 | Posterior | Fracture of acetabulum | Right | Riding in car | Traction for 7 weeks. | | 4 hours | ? | 8 weeks |
| 8. J. H. | Male | 45 | Posterior | Fracture of acetabulum | Left | Riding in car | Traction for 6 weeks. | | 1 hour | Good | 5 years |
| 9. D. S. | Male | 31 | Obturator | | Right | Thrown from car | Immediate. In bed for 2 weeks. | | 4 hours | Good | 5 years |
| 10. K. H. | Male | 51 | Posterior | | Right | Hit by car | Immediate. Cast for 7 weeks. | | 2 hours | Good | 2 years |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11. J. W. | Male | 8 | Posterior | | Right | Hit by car | Immediate. Traction for 4 weeks. | | 3 hours | Good | 2 years |
| 12. C. G. | Female | 45 | Posterior | Fracture of acetabulum | Right | Riding in car | Immediate. Traction for 4 weeks. Cast for 4 weeks. | | 12 hours | Fair | 3 years |
| 13. G. G. | Male | 63 | Posterior | Fracture of acetabulum | Right | Fell from tree | Traction for 8 weeks. | | 3 hours | Good | 4 years |
| 14. D. S. | Male | 48 | Posterior | Fracture of acetabulum | Right | Riding in car | Immediate. Traction for 6 weeks. | | 5 hours | Poor. Aseptic necrosis. | 6 years. Motion limited. Pain. |
| 15. R. S. | Male | 13 | Posterior | Fracture, with femoral neck in acetabulum | Right | Riding in car | | Ivory pin | 3 weeks | Poor. Aseptic necrosis. | 5 years. Motion fair. Shortening of 1¼ inches. |
| 16. M. D. | Female | 35 | Obturator | Fracture, with chip off neck | Right | Thrown out of car | Immediate. Traction. | | 3 hours | ? | 5 weeks |
| 17. B. C. | Male | 10 days | Posterior | | Right | Podalic version | Immediate. Cast for 10 days. | | 10 days | Good | 5 years |
| 18. T. D. | Male | 46 | Posterior | Fracture of acetabulum | Right | Riding in car | Traction for 10 weeks. | | 2 weeks | Fair. Aseptic necrosis. | 6 months |
| 19. M. M. | Male | 46 | Posterior | | Right | Riding in car | | Resection of head. Neck in acetabulum. | 15 months | Poor. Aseptic necrosis. | 3 months |
| 20. A. H. | Male | 23 | Posterior | Fracture of acetabulum | Right | Fell from boxcar | | Shelf operation | 8 months | Poor. Aseptic necrosis. | 8 months. Hip partly redislocated. |



FIG. 2

Case 2. Posterior fracture-dislocation of the head of the femur; neck in acetabulum.



FIG. 3

Case 2. Ten months after injury. Full range of flexion. Adduction and rotation limited.

us to feel that such an incision creates too great a handicap to the proper shelving of the posterior portion of the roof of the acetabulum.

An analogous case was reported by Henry and Bayumi. The proximal portion of the femur of a woman sixty years of age was removed and the neck was inserted into the acetabulum. These authors stated that three inches of shortening resulted, but they did not mention the range of motion.

Platt pointed out the danger of injury to the sciatic nerve and of fracture of the neck of the femur when manual reduction is attempted more than a few weeks after dislocation. If uncontrollable bone fragments are present at the time of manual reduction, he felt that their removal at operation, six to eight weeks after reduction, improves motion and lessens pain.

Bunne reported a good result in his case, that of a woman forty-four years old, after open reduction of an obturator dislocation, in spite of the presence of myositis ossificans and of some necrosis of the head.

Six of our cases demonstrated the possibility of development of aseptic necrosis, as described by Phemister and by Dyes. Two of the cases reported by Dyes showed changes almost identical with those seen in Legg-Perthes disease. Apparently injury to the nutrient arteries of the neck is necessary, in addition to rupture of the ligamentum teres, for the development of severe necrotic changes.




FIG. 4

Case 19. Dislocation unreduced, fifteen months after injury.



FIG. 5

Case 19. Five weeks after operation consisting of open reduction, decapitation, and replacement of the neck in the acetabulum.



FIG. 6

Case 19. Three months after operation.



FIG. 7
Case 9. Uncomplicated obturator dislocation.

Stewart reported a case of simple dislocation in which good recovery was apparently being made at the end of two months, but, at the end of five months, there was increasing limitation of motion because of the gradual development of ossification in the capsule and breaking down of the head. The head later became transformed, but at the expense of motion.

This type of degenerative change in the joint took place in one of the cases (Case 14) of this series.

CASE 14. D. S., a physician, aged forty-eight, received a dislocation of the right hip with a fracture of the posterior rim of the acetabulum. Good recovery of function was apparently taking place, but, at the end of four or five months, increasing lameness and pain in the hip developed. Roentgenographic examination showed partial absorption of the head with calcification of the capsule. Transformation gradually took place in the head, but, on observation six years after injury, the patient showed marked limitation of motion of the hip, walked with a decided limp, and had pain.

Our youngest patient (Case 17), a new-born boy, received a traumatic dislocation as a result of podalic version in delivery. This case has been included in the series with apologies to the "dashboard syndrome". The dislocation was upward and backward and was easily reduced under a very short anaesthesia. A cast was applied from the toes to the chest for a period of ten days, and no further treatment was given. The patient was reexamined five years later, and the hip was apparently normal in every respect.

Such dislocation in children is rare, but cases have been reported by Glynn, and Mauck and Anderson. The only other child who came under our observation was a colored boy, aged eight (Case 11). Goetz reported a traumatic dislocation of the hip into the scrotum occurring in a boy ten years of age, and Campbell reported a perineal dislocation in a boy of eleven.

Two of our patients (Cases 9 and 16) had obturator dislocations. In one case (Case 9), the dislocation was uncomplicated by fracture (Fig. 7). In the other (Case 16), a large chip was torn loose from the upper surface



FIG. 9

Case 16. After reduction. Note defect in neck.



FIG. 8

Case 16. Obturator dislocation with avulsion fracture of the neck.

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# THE SPASTIC HAND

BY MICHAEL S. BURMAN, M.D., NEW YORK, N. Y.

*From the Hospital for Joint Diseases* *

The surgery of the spastic hand is neglected. This has been emphasized by Brockway. In a study of 1000 spastic children, on whom 542 operations had been done, the author found that the upper extremity itself received surgical attention only sixty-five times. The hand, exclusive of the wrist, was operated upon ten times, nine of the operations being directed at the oppositional deformity of the thumb.

This study is the result of clinical observation on the effect of curare in spastic paralysis. It includes the study of persistent spastic opposition position and contracture of the thumb, with or without flexion of the terminal phalanx of the thumb; spastic adduction contracture of the thumb; spastic intrinsic hyperextension of the fingers; spastic flexion-abduction position of the fingers; and, finally, spastic anterior subluxation of the first metacarpal head. A solution was sought for every hand deformity which did not yield to curare or hindered its effects. It is to be emphasized that this is not a final study of end results, since the period of postoperative observation is too short. Most of the cases have been followed for at least a year after operation.

## PERSISTENT SPASTIC OPPOSITION POSITION OF THE THUMB, WITH OR WITHOUT FLEXION OF ITS TERMINAL PHALANX

The thumb is drawn into the palm in constant or inconstant position in opposition by the action of the three muscles whose fleshy bellies together make the thenar eminence,—the opponens pollicis, the flexor pollicis brevis, and the abductor pollicis brevis.

The hand encloses the thumb, and it becomes impossible to grasp any object, either passively or actively. In mobile spastics, the passive stretching of the extensors of the thumb in palmar flexion of the wrist sometimes forces the thumb out of the hand, but it reenters the palm on dorsiflexion of the wrist. This is not invariably true, and the thumb may be retained in the palm even though the wrist is in palmar flexion.

The index and middle fingers are sometimes placed more dorsally than the ring and little fingers, because of the indrawing of the thumb. In the presence of frequent spasm of the index finger, the skin over the dorsal aspect of the metacarpophalangeal joint of the thumb may become excoriated and keratotic. Dissociated action of the thenar muscles sometimes exists. The thumb is not opposed. The first metacarpal bone is abducted by the abductor pollicis longus, and the thumb is flexed at the metacarpophalangeal joint by the flexor pollicis brevis, the terminal phalanx being hyperextended.

* Service of Leo Mayer, M.D.

of the neck, which had apparently been avulsed by the capsule when it became detached (Figs. 8 and 9). Such cases seem to be subject to aseptic necrosis.

## CONCLUSIONS

1. The immediate reduction and traction treatment of uncomplicated dislocation of the hip gives uniformly good results.

2. When the dislocation is accompanied by a formidable fracture, the prognosis should be guarded, because of the possibility of development of aseptic necrosis and periarticular ossification.

3. The longer the hip stays out of place the poorer are the prospects of obtaining a satisfactory result by operation.

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flexor carpi radialis to the extensor pollicis longus to secure active abduction of the thumb. He also shifted this same tendon to the abductor pollicis longus, together with one-half of the extensor carpi radialis, for the same purpose. The Stoffel operation has been recommended not only by Stoffel but by other authors, such as Gill and Heyman. This operation is not now usually done, but Brockway does a complete or partial resection of the nerve supply to the opponens pollicis or flexor pollicis brevis, with a fair end result.



FIG. 1-B

Case G. W. The appearance of the thumb after operation.

Foerster and, later, Silfverskiöld did a tenomyotomy of the muscles which terminate on the ulnar sesamoid of the thumb, or a myotomy of the opponens pollicis. The adductors seem to have been cut also. Silfverskiöld used this method with good results. This operation is comparable to the one which the author is describing, but both Foerster and Silfverskiöld placed undue emphasis on the adductors of the thumb. The writer's plan of operation was independently conceived and only in the investigation of the literature did he come upon their work.

The aim of the operation is the lessening of the leverage which the spastic muscles exert on the thumb by the stripping of the common tendon of insertion, with or without plastic lengthening of the flexor pollicis longus at the wrist.

The operation should be a final procedure rather than an initial one,—final in the sense that other operations, such as tendon transplantation at the wrist, precede it. This is so for two reasons: First, we must allow the spastic hand enough time for readjustment after an operative procedure to determine how much has been gained and what is next needed; second, the position of the thumb may change in varying positions of the wrist. The operative procedure for the thumb cannot be carried out until the final position of the wrist is determined. This is not so easy, since many spastics use their fingers better in palmar flexion of the wrist.

*Operative Technique*

The operation is best done under local anaesthesia. The incision is longitudinal, placed on the anterior radial border of the thumb, and

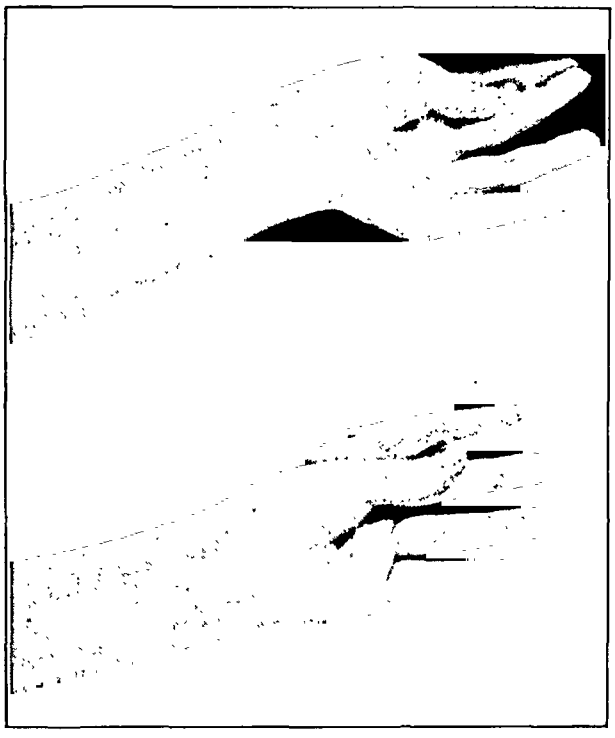


FIG. 1-A

Case G. W., female, aged twenty-two, showing the spastic indrawing of the thumb. This case is not described in the text.

The terminal phalanx of the thumb is often flexed by spasm of the flexor pollicis longus. This flexion increases the positional deformity of the thumb. The flexor pollicis longus acts in the manner of a bowstring as a secondary opponens of the thumb. The thumb executes its final position of opposition easily with flexion of the terminal phalanx. Opposition is more difficult in extension of the terminal phalanx, and, in the normal hand, strain is felt in the short muscles of the thumb in this position. In some spastic thumbs, flexion at the metacarpophalangeal joint of the thumb with extension of the terminal phalanx is seen. This is comparable to the intrinsic-muscle position of a finger. The flexion of the basal phalanx is due to action of the flexor pollicis brevis; the extension need not be an active extension, but may be passive by pull of the fascial band which passes from the abductor pollicis brevis to the extensor pollicis longus. Opposition position of the thumb is not as marked in terminal-phalanx extension.

The *position in opposition* can in time become *contracture in opposition.* The author has noted this twice. This contracture in opposition is present only in the older spastics in whom the deformity has existed for many years. The atrophied muscles have long ceased to respond to hyperinnervational impulses. The first metacarpal bone is drawn in front of the second metacarpal and is more or less immovable in that position, not only by muscle contracture but also by contracture in the carpometacarpal joint of the thumb. An unusual complication is medial rotation of the thumb by pull of the thenar muscles, when a fixed anterior subluxation of the first metacarpal head exists. The thumb is so twisted that the nail faces the palm and the pulp of the thumb faces outward.

There have been many operative attempts to correct persistent opposition position of the thumb. Dowd noted that Hoffa shortened the extensor pollicis longus. This operation is comparable to the tendon transplantation of Biesalski and Mayer, in which the extensor indicis proprius is attached to the long extensor of the thumb. Vulpius and Stoffel shortened the abductor pollicis longus. Hoffa transplanted the

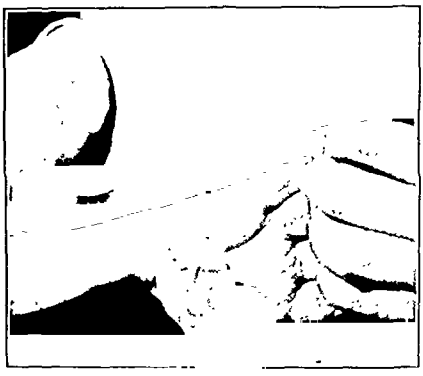


FIG. 2-A

Case A. O., female, twenty-four years of age, before operation.



FIG. 2-B

Case A. O., after operation. A flexion position of the terminal phalanx of the thumb has recently developed. The thumb is kept out of the palm.

possible. However, as a rule, the operation gives no active power of abduction unless the abductor pollicis longus has some strength. If a tendon transplantation which will give abduction can be done, it should be done in combination with the operation of thenar stripping. A good result may be expected if the transplanted tendon has actual power; usually, the transplant is paretic. The appearance of the hand after thenar stripping is nearer the normal and the thumb no longer falls into the palm. It is maintained at the side of the hand somewhat ahead of the fingers. In the irritable spastics, the thenar muscles contract as frequently as before operation, but, since the insertion point has been lowered, they do not draw the thumb into the palm.

There has been no recurrence of deformity in any of the cases in which the operation has been done.

Certain minor complications must be avoided. If the joint capsule is opened, there may develop slight restriction of flexion of the metacarpophalangeal joint of the thumb with pain over its anterior capsule. This may persist for several months. If the thumb is immobilized in too much extension, a slight anterior subluxation of the first metacarpal head may take place. In a mobile spastic hand, a mild degree of valgus deviation of the thumb may come about.

A long period of physiotherapy follows the operation and this is supplemented sometimes with curare. Hand exercises are beneficial.

*Illustrative Cases*

T. G., a girl of nineteen, had a left hemiplegia of syphilitic etiology. The left hand showed spastic indrawing of the thumb with terminal-phalanx flexion. The fingers were clenched over the thumb. The wrist was acutely flexed. The hand showed no active power. Thenar stripping of the left thumb, with lengthening of the flexor pollicis longus at the wrist, was first done, followed several months later by lengthening of the wrist flexors.

The period of observation has been more than a year. There still is no active power in the hand. The thumb is out of the palm and shows no tendency to be drawn into it. It rests usually at the side of the hand and a little in front of it. The terminal phalanx of

extends from one-half an inch above the point of thenar insertion down along the length of the shaft of the first metacarpal bone. The superficial branch of the radial nerve is avoided. The opponens pollicis is stripped subperiosteally from the shaft of the first metacarpal. The common tendon is exposed as it inserts diagonally on the prominent tubercle on the outer side of the first phalanx. The tendon is severed from its point of insertion and stripped proximally for at least three-quarters of an inch. It is important that the most ulnar part of the tendon, contributed by the flexor pollicis brevis, be severed. The capsule of the metacarpophalangeal joint may be cut if contracted, and the joint may be opened. The common tendon, which is from one-half to three-quarters of an inch long, is excised after it has been stripped. The wound is closed in layers. The thumb is immobilized in abduction and extension in the plane of the hand for three weeks.

*Plastic Lengthening of the Flexor Pollicis Longus at the Wrist*

It is simplest to lengthen the tendon at the wrist, above the tendon sheath and near the musculotendinous junction. The tendon can be picked up through a one-inch longitudinal incision above the wrist joint. The tendon of the flexor carpi radialis acts as a guide. It is not necessary to isolate the median nerve, although the author has done so. The tendon is deep in the wrist, and is a peculiarly elusive tendon to find. It lies about midway between the tendon of the flexor carpi radialis and the pronator quadratus; it is nearer the former than the latter. It is lengthened by a Z-shaped incision, the ends being secured by a Bunnell-Mayer stitch. The wound is closed in layers.

In the presence of very marked spasticity, the question of how much to lengthen this tendon becomes a matter of judgment, especially in spasticity of the intermittent, surging type. *It is better to lengthen the tendon too little than too much.* The reverse deformity of *spastic hyperextension of the thumb* is brought about, and, in the period of irritability following the readjustment of the spastic hand, the overactive and unopposed extensors of the thumb can cause a forward subluxation of the head of the first metacarpal. This complication is prevented by immobilization of the thumb in slight flexion. When this complication is present, a splint, holding the thumb in abduction and in slight terminal flexion, with pressure dorsally against the anteriorly protruding metacarpal head, should be applied as long as necessary. This complication is ultimately overcome in full or in part by readjustment of the flexor-extensor balance.

The author has done the operation of thenar stripping eight times. A ninth case was done on the service of Dr. Finkelstein, in which, in addition to thenar stripping, the flexor carpi radialis was transplanted to the abductor pollicis longus. The result is too recent to estimate yet.

The patient may be able to abduct the thumb actively immediately after the operation, whereas before operation this action had never been

proximal interphalangeal joints in extension. The spasticity is uneven and is greatest in the thumb adductors, or it may be an isolated expression of ulnar-nerve spasticity.

The disability resulting from adduction contracture is twofold. The thumb cannot be abducted in the plane of the hand to encircle an object. The tight adductors restrict the ability of the thumb to oppose, so that it may be possible only to bring the thumb to the index finger.

The contracture is quite uncommon, but probably more common than is suspected. The author has found only one reference to this condition. Vulpius and Stoffel have noted that in adduction contracture of the thumb an open section of the adductors is to be done. The adductors are approached by a volar transverse incision.

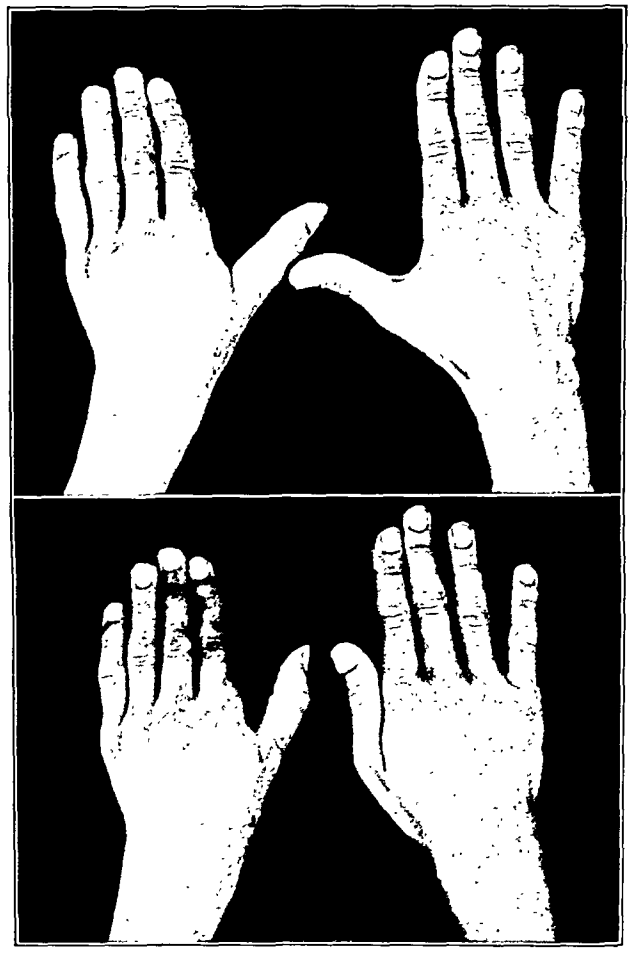


FIG. 3-B

Case S. E., after operative correction of the deformity of the thumb. The voluntary abduction is shown above, adduction below.

*Operative Technique*

A longitudinal incision is made, running parallel to the shaft of the first metacarpal bone along its ulnar border. It extends about one-half an inch above the tubercle insertion of the adductors and runs the entire length of the metacarpal. The tendon of the extensor pollicis longus is retracted laterally in the outer margin of the wound. A digital branch of the radial nerve, which courses obliquely upward and medially from the lower angle of the wound, is avoided. The first dorsal interosseous muscle is stripped subperiosteally from the shaft of the first metacarpal. The combined tendon of insertion of the two adductors is seen in the bottom of

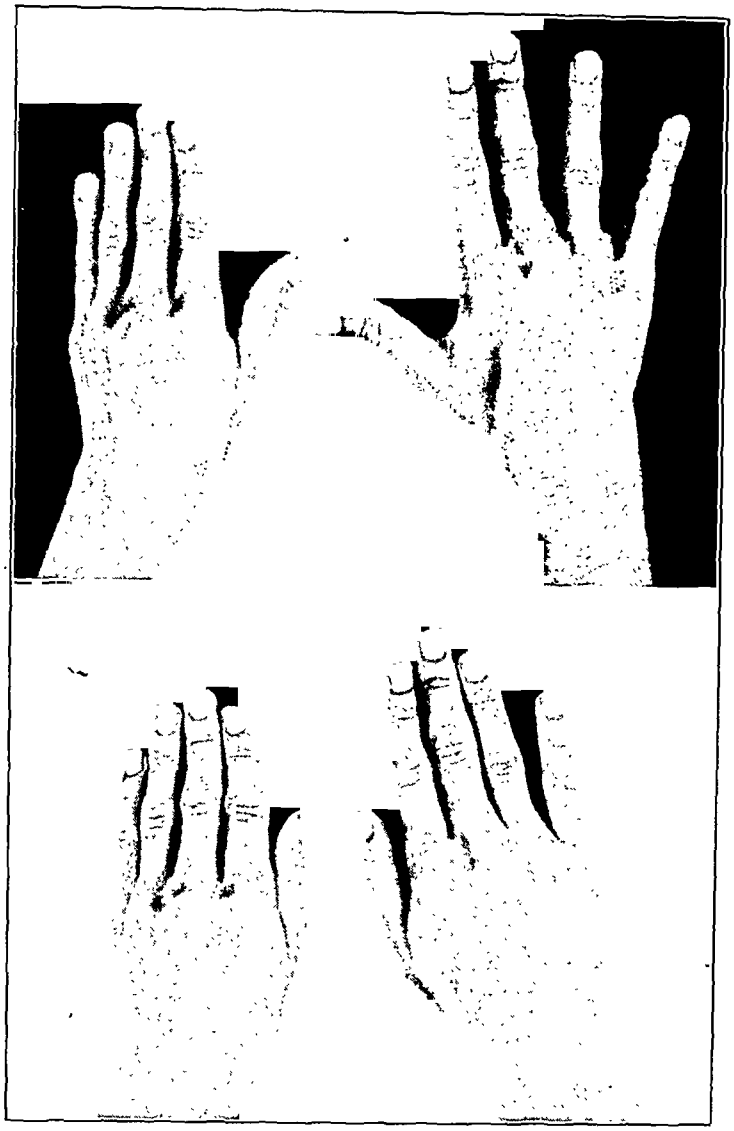


FIG. 3-A

Case S. E., male, sixteen years of age, showing spastic adduction contracture of the left thumb. The power of voluntary abduction is illustrated above, that of voluntary adduction below.

the thumb is held in about 5 degrees of flexion. There is no tendency to reverse deformity of hyperextension of the terminal phalanx of the thumb, since the extensors have neither intermittent spasm nor power. The wrist is held in 160 degrees of palmar flexion. The fingers respond to continuous stretching, but become flexed again after release of the stretching force. The appearance of the hand is improved from a cosmetic standpoint, although there is very little functional use of the hand.

A. O., female, twenty-four years old, had a fixed opposition contracture of the right thumb of many years' duration. (See Figure 2-A.) The thumb could be passively abducted a little, but this caused an anterior subluxation of the first metatarsal head.

On May 13, 1936, the deformity was corrected by the stripping operation with the addition of a capsulotomy of the carpometacarpal joint.

The patient was last seen in November 1936. The thumb rested at the side of the hand just anterior to the palm. Flexion of the terminal phalanx of the thumb was developing and was a little troublesome, since the thumb got in the way of the index finger. (See Figure 2-B.) The flexed wrist had been arthrodesed.

## SPASTIC ADDUCTION CONTRACTURE OF THE THUMB

Adduction contracture of the thumb is due to contracture of the first dorsal interosseous muscle and the adductor pollicus obliquus and the adductor pollicis transversus. *It is a contracture in the plane of the hand,* and the thumb does not lie anterior to the palm. It represents expression of increased spasticity in the area of distribution of the motor branch of the ulnar nerve. It may thus be coincident with an intrinsic position of the fingers, the metacarpophalangeal joints being in flexion and the

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the distal part of the wound. Section of the tendon between clamps is carried close to the bone. This overcomes the adduction contracture. Care should be taken in section of the adductors, since just anterior to them and separated from them by a thin but distinct fascial plane lies the principal artery of the thumb. The long flexor of the thumb is still more anterior. The wound is closed in layers and the thumb is immobilized in full abduction in the same plane of the fingers. Gauze-pad pressure is made anteriorly and posteriorly to the web of the thumb to prevent postoperative hematoma. Immobilization is maintained for about three weeks, when exercises are begun.

The author has corrected adduction contracture of the thumb in two cases. In one, the intrinsic-muscle imbalance * of the fingers was absent, and in the other it was so slight that resection of the motor division of the ulnar nerve could not be considered. The result in both cases was good. Active abduction and adduction were attained. There is early reformation of the adductors, even at three weeks after operation, so that inability to adduct the thumb need cause no worry. Thenar opposition was still limited in one case; in the other it was good.

*Illustrative Case*

S. E., a boy of sixteen, showed an adduction contracture of the left thumb (Fig. 3-A). Abduction of the thumb in the plane of the hand was greatly lessened. On August 14, 1935, under general anaesthesia and with the use of the tourniquet, the operative release of the deformity was done. The postoperative course was uneventful, and the wound healed *per primam.* (See Figure 3-B.) The patient was seen last on May 9, 1936. Good adduction and abduction of the thumb, especially passively, were present. Reformation of the adductors had taken place, so that the power of adduction of the thumb was not lost. The patient demonstrated a mild intrinsic position of the fingers.

## SPASTIC HYPEREXTENSION OF THE FINGERS IN INTRINSIC-MUSCLE IMBALANCE

Hyperextension of the proximal and distal interphalangeal joints is associated with flexion of the metacarpophalangeal joints in intrinsic-muscle imbalance. In extensor spasm, which is not usual, there is extension of the fingers also, but extension, rather than flexion, at the metacarpophalangeal joints. It is not uncommon to observe the intrinsic position in mobile spastics, but this position is a changing one. Fixed deformity can occur, and for this Steindler resected the motor branch of the ulnar nerve. The average spastic hand seldom exhibits that great degree of hyperextension sufficient to warrant operative interference. Not every hand in spastic intrinsic imbalance is useless, for a mild degree may allow active hand power and require no operation. The degree of deformity of this type of hand may fluctuate, or the deformity may shift intermittently,

* The term "intrinsic-muscle imbalance" refers to an imbalance existing between the extrinsic and intrinsic muscles, in favor of the intrinsic muscles. The fingers assume a position of flexion at the metacarpophalangeal joints and extension at the interphalangeal joints. Abduction or adduction of the fingers may be present in the intrinsic position, depending on the preponderance of power in either dorsal or volar interossei.

so that the fingers may be clenched or extended. The obliquely coursing collateral extensor tendons stand out as taut bands beneath the skin in intrinsic or extensor spasm. The wrist is palmarly flexed or fused in dorsal position, or it alternates between dorsiflexion and palmar flexion. No "pill roller" hand was observed, and the observation of Steindler that the deformity can only exist in dorsiflexion could not be substantiated. Spastic intrinsic-muscle imbalance was present in hands whose wrists were either dorsally or palmarly flexed, although the intrinsic-muscle position is more easily taken in dorsiflexion of the wrist.

The operative procedure consists in the proximal stripping of the collateral extensor tendons to the mid-part of the first phalanx, a point well below the hyperextended joint. The common extensor tendon must be cut transversely or lengthened, for, if this is not done, recurrence of the extension deformity will take place. There is a certain sympathy in spastic hands by which an operative procedure directed at one point diminishes spasticity at another point. The author, therefore, has confined the operation to the usually more severely affected index and middle fingers, believing that release of hyperextension of these fingers would diminish the hyperextension of the fourth and fifth fingers. Clinically, he has noted that hyperextension is greatest in the index finger and diminishes progressively to the little finger.

The stripping must be thorough. If it is incomplete, an unusual position of the finger is assumed. The proximal interphalangeal joint goes into a lesser hyperextension than before operation, while the terminal phalanx is flexed because of the action of the now stronger flexor profundus tendon. This is a position which can only be assumed voluntarily by a normal finger as a trick motion. The index finger may rest in a plane higher than the middle and other fingers after operation. The writer believes that this is due to the presence of two extensor tendons to the index finger. He has observed only once the little finger of a spastic hand in a plane higher than the ring and middle fingers; it was on a line equal with the index finger.

The proper end result should be a more even balance between flexion and extension of the finger.

*Operative Technique*

Two incisions are made on each finger,—one placed radially and one ulnarly. The incision begins at about the mid-part of the second phalanx, and runs obliquely and proximally in the line of the collateral extensor tendon to about the mid-part of the first phalanx. Each collateral tendon is identified, severed transversely distally, and stripped proximally. The entire tendinous band is removed at the mid-part of the first phalanx, below the proximal interphalangeal joint. False dissection must be avoided. The thin central fascial extension over the second phalanx is untouched, and it is through its action that extension is hoped for. The common extensor tendon is sectioned transversely at the level of the

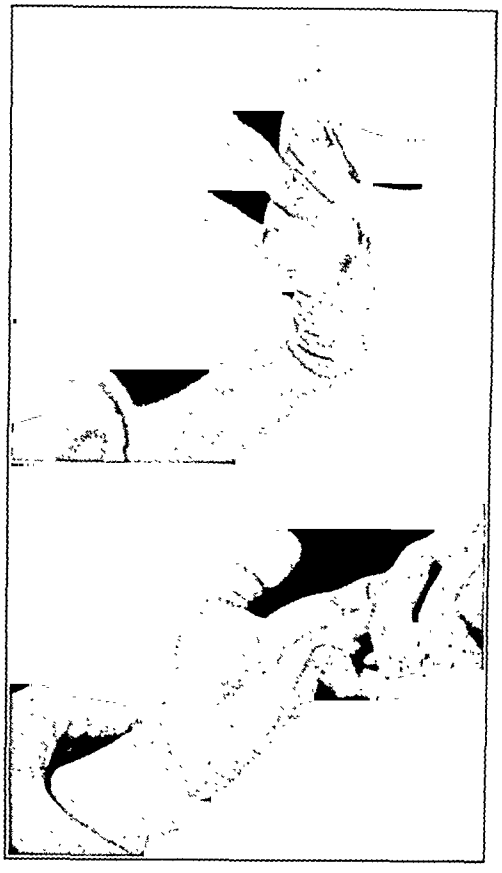


FIG. 4-A

Case E. F., a girl of fourteen, with a left hemiplegia. The extreme intrinsic hyperextension of the fingers is shown above. The thumb is kept out of the palm after a thenar stripping as shown below.

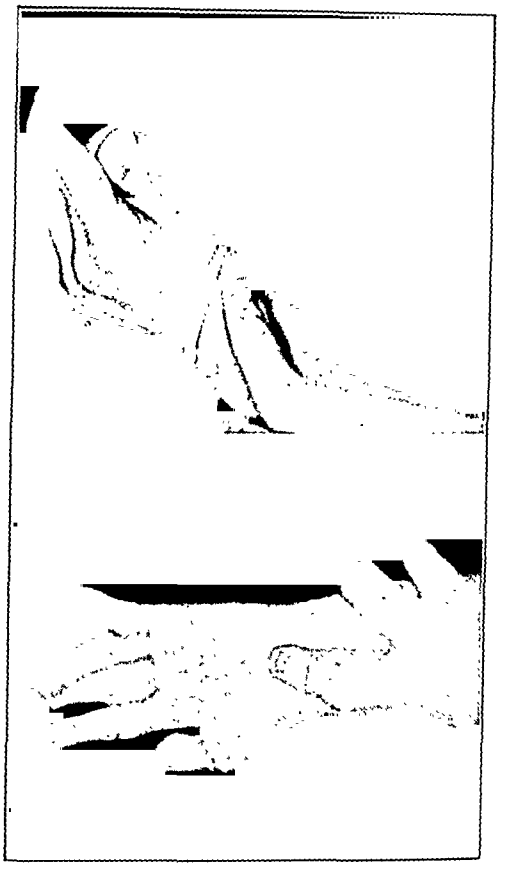


FIG. 4-B

Case E. F. The photograph below shows the opened hand, with the wrist held passively in dorsiflexion; that above shows the peculiar flexion position of the terminal phalanx of the index finger after incomplete division of its extensors. The thumb is out of the palm, but its terminal phalanx is in hyperextension following a lengthening of the flexor pollicis longus.

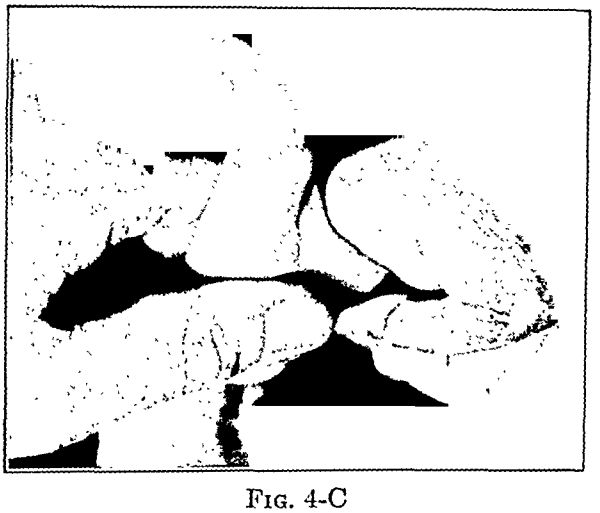


FIG. 4-C

Case E. F. The appearance of the index finger after reoperation upon the extensors.

proximal interphalangeal joint. It slips back about three-eighths of an inch, but further retraction is not allowed, since it is held in the extensor aponeurosis. The wound is closed, and the finger is bandaged in flexion.

*Illustrative Case*

The left hand of E. F., a girl fourteen years old, showed an extreme intrinsic spastic hyperextension deformity of the fingers and spastic indrawing of the thumb into the palm with terminal-phalanx flexion. (See Figure 4-A.) On April 24, 1935, a thenar stripping was

done under local anaesthesia. On August 21, 1935, the flexor pollicis longus was lengthened, and the collateral extensor tendons of the index and middle fingers were stripped. (See Figure 4-B.) It was necessary to reoperate on the index finger, since hyperextension of the proximal interphalangeal joint was still present. This was done on April 1, 1936, and the common extensor tendon was cut transversely at the level of the proximal interphalangeal joint. (See Figure 4-C.)

The patient was last examined in September 1937. The thumb was kept out of the palm. The terminal phalanx of the thumb was usually in some hyperextension. A mild valgus deviation of the thumb (pollex valgus) was noted, with protrusion of the head of the first metacarpal radially. This was due to opening of the lateral joint capsule and to the bowstring action of the medially displaced long extensor tendon. The index and middle fingers were flexed, especially by the action of the flexor sublimis. A certain amount of extension of the fingers was allowed, so that the patient used the hand better as a support when eating or doing ordinary work.

## SPASTIC FLEXION-ABDUCTION POSITION OF THE FINGERS

Spastic flexion-abduction position of the fingers is maintained by a spasticity of the interossei dorsales in excess of the interossei volares. The author has not seen spastic contracture in flexion-adduction of the fingers.

### *Illustrative Case*

F. B., male, thirty-seven years of age, has a residual disability of the left hand following a sudden stroke on December 27, 1934. This disability is a spastic intrinsic flexion-abduction position of the fourth and fifth fingers. (See Figures 5-A and 5-B.) The fingers are flexed at the metacarpophalangeal joints and extended at the proximal interphalangeal joints. They are also abducted and cannot be adducted in the intrinsic position. The middle finger is in neutral position, and the index finger is held in extension at the metacarpophalangeal joint and in slight flexion at the interphalangeal joints. The patient has a fair amount of strength in the hand, but the grip cannot be

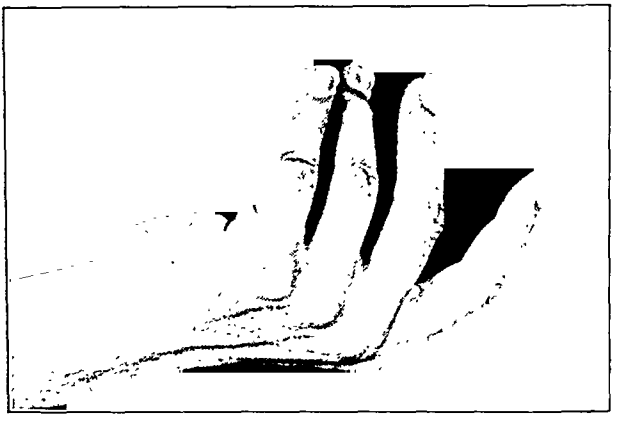


FIG. 5-A

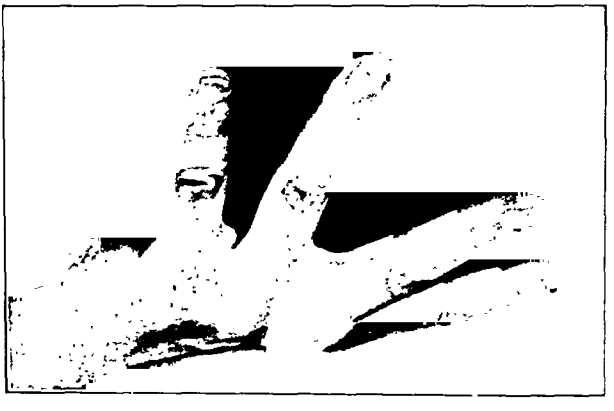


FIG. 5-B

Case F. B., male, thirty-seven years of age, showing the spastic flexion-abduction position of the fingers.

maintained. He can pick up vertically placed objects only by cupping his hand.

The disability of his hand is due to a spastic imbalance of the intrinsic muscles of the hand in favor of the interossei dorsales. Most of the spasticity is confined to the distribution of the motor branch of the ulnar nerve. This nerve was injected with novocain, the injection being made between the pisiform and hamate bones, with resultant ulnar-nerve hypaesthesia and a feeling of looseness in the affected fingers. The reverse deformity was not produced. The stripping of the affected interossei dorsales has been recommended.

### SPASTIC ANTERIOR SUBLUXATION OF THE HEAD OF THE FIRST METACARPAL BONE

This is a not uncommon subluxation of the spastic thumb and is due usually to overpull of the long and short extensors of the thumb, so that, by a bowstring action, the head of the first metacarpal is forced forward. It may be due in some cases to pull of the flexor pollicis brevis, but this is less usual as an etiological factor. It is not surprising that such a subluxation may develop, since it may be present in the normal hand as a trick motion by extensor action in loose-jointed individuals. Rarely, it may exist as a fixed deformity. It is ordinarily not an isolated phenomenon in spastic paralysis and is almost always associated with thenar-muscle spasm. It may develop after operation in a patient in whom it has not existed before. In a spastic mobile hand, it will surely come on after lengthening of the flexor pollicis longus. The balance of power then swings over to the extensor side of the thumb. It may develop in a non-mobile spastic hand after stripping of the thenar muscles, if the metacarpophalangeal joint has been opened and the thumb immobilized in slight extension. Therefore, after these procedures care should be taken to put pressure dorsally upon the head of the first metacarpal, either by splint or by plaster.

### COMMENT

In this consideration of the spastic hand from a kinesiological viewpoint, especial emphasis has been placed on those constant elements in spastic position which are conditioned by spasticity of the intrinsic muscles. The extrinsic spastic hand has not been considered, since the author has observed only one case of extrinsic hyperextension deformity of the fingers.

The operative procedures described for the correction of spastic opposition position or contracture of the thumb, spastic adduction position of the thumb, and marked intrinsic hyperextension of the fingers are not intended to be complete in themselves as a form of therapy. They are only aids in the treatment of a hand whose spasticity should be relieved by curare and whose education should be lifelong.

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# SPASTIC INTRINSIC-MUSCLE IMBALANCE OF THE FOOT

## RESECTION OF THE MOTOR BRANCH OF THE LATERAL PLANTAR NERVE FOR INTRINSIC-MUSCLE CONTRACTURE

BY MICHAEL S. BURMAN, M.D., NEW YORK, N. Y.

*From the Hospital for Joint Diseases* *

Spasticity of the intrinsic muscles of the foot results in flexion of the toes at the metatarsophalangeal joints and extension or hyperextension at the interphalangeal joints. There may be fixed contracture or mutable position of the toes. The great toe is flexed at its metatarsophalangeal joint by pull of the flexor hallucis brevis and extended at the interphalangeal joint.

This deformity of the foot corresponds to the more common spastic intrinsic-muscle deformity of the hand. In the hand, it is the motor branch of the ulnar nerve which innervates the intrinsic muscles; in the foot, it is the motor branch of the lateral plantar nerve by which these muscles are innervated. This nerve supplies all the interossei except those in the fourth intermetatarsal space, which have their own little twig from the proper digital nerve of the superficial branch of the lateral plantar nerve. The first interosseous dorsalis muscle often receives a twig from the medial branch of the deep peroneal nerve; the second interosseous dorsalis muscle, from the lateral branch of the same nerve. The second, third, and fourth lumbricales and the adductor hallucis are also

* Service of Leo Mayer, M.D.

supplied by the motor branch. The first lumbricalis and the flexor hallucis brevis are innervated by branches from the medial plantar nerve.

Sometimes the action of the intrinsic and extrinsic muscles is not coordinated, so that one or more of the toes may be in the intrinsic position and the others in the extrinsic position. This is found in mobile spastics, especially in dystonics.

It is the poor pivotal support of the toes which makes walking and standing difficult that makes necessary some form of operation in fixed intrinsic contracture of the foot. Resection of the motor branch of the lateral plantar nerve, plus plantar capsulotomy of the metatarsophalangeal joint of the great toe and section of the heads of insertion of the flexor hallucis brevis, is the operation of choice. Resection of part of the posterior tibial nerve at the level of the internal malleolus is also to be considered.

The development of the contracture is theoretically hindered by an equinus position of the foot, which creates a passive insufficiency of the dorsiflexors of the foot.

## TECHNIQUE OF THE OPERATION

The bony landmark is the styloid tuberosity of the fifth metatarsal bone. A four-inch longitudinal incision, which begins about three-quarters of an inch proximal to the styloid tuberosity, is made on the sole



FIG. 1-A

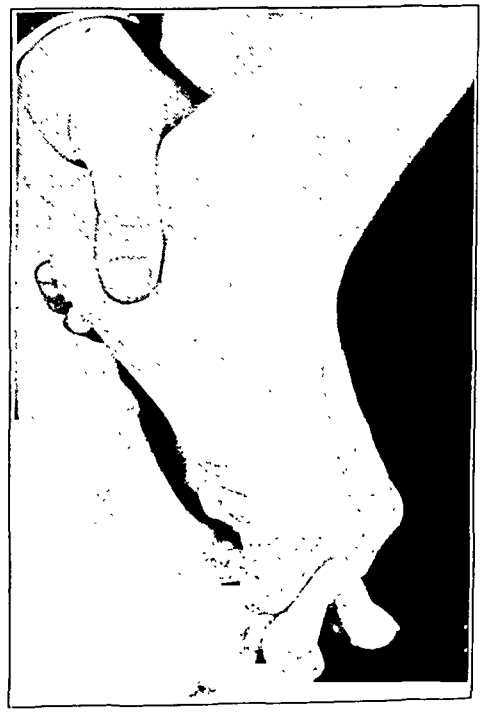


FIG. 1-B

H. K., before operation. The toes are sharply flexed at the metatarsophalangeal joints and hyperextended at the interphalangeal joints. An equinus deformity of the foot is present.

of the foot in the groove which indicates the line of separation between the central and lateral compartments of the sole of the foot. The lateral plantar nerve runs obliquely, distally, and laterally in the proximal part of the wound, a little proximal to the line of the styloid tuberosity of the fifth metatarsal. The nerve lies beneath the plantar fascia, between the flexor digitorum brevis and the quadratus plantae muscles. These muscles need not be isolated. The tendency is to cut too deeply, whereby both nerve and vessels may be severed at their point of proximal bending. The lateral plantar artery lies just proximal to the nerve at the point of bending of the nerve. Distal to this bend, the nerve runs in the space between the central and lateral compartments. The nerve is dissected out and the motor branch and the twig to the fourth interosseous space are isolated. The motor branch is placed dorsomedially on the common trunk of the nerve before its division. The twig to the fourth interosseous space arises from the proper digital branch to the fifth toe. The branches, once identified, are cut, and the wound is closed in layers.

The plantar aspect of the metatarsophalangeal joint of the great toe is approached by a medial longitudinal incision. Both heads of the flexor hallucis brevis are cut, and the plantar capsule is opened. An incision in the plantar crease of the great toe is made distal to the metatarsophalangeal joint. In the following case, this approach was not used, and a longitudinal incision over the ball of the toe was made. This is not a satisfactory incision.



FIG. 2

H. K., after operation. This picture was taken before the patient's discharge from the hospital in the early part of October 1936, showing the appearance of the toes after resection of the motor branch of the lateral plantar nerve and the twig to the fourth interosseous space. A plantar capsulotomy of the metatarsophalangeal joint of the great toe was also done, together with section of the heads of the flexor hallucis brevis. This improvement has persisted and was so noted at the patient's last examination on October 17, 1937, fourteen months after operation. The appearance of the toes now is as seen in this picture.

### CASE REPORT

H. K., male, aged thirty-five, was admitted on March 3, 1936, for the correction of multiple deformities due to spastic paraplegia. The deformities of the right hip and knee were corrected. The results of these operations were good. Accurately fitting braces were applied, but walking with braces and crutches was very difficult because of lack of training and a deformity of the toes of the right foot which gave no pivotal support to the foot. The toes were flexed sharply at the metatarsophalangeal joints and hyperextended at the interphalangeal joints, in fixed contracture. The terminal phalanx of the fifth toe was flexed rather than extended, probably by shoe pressure. The great toe was flexed at the metatarsophalangeal joint and extended at the interphalangeal joint in fixed deformity. An equinus deformity of the right foot was present. There was no active muscle power in the right foot. The toes of the left foot were in a fairly neutral position.

On April 5, 1936, five cubic centimeters of 2-per-cent.-

novocain solution was injected into the sole of the right foot in the region of the motor branch of the lateral plantar nerve. Hypaesthesia of the fourth and fifth toes followed. The hyperextension of the fourth and fifth toes gave way to a more neutral position of the toes; that of the second and third toes was not so markedly diminished. There was no hyperextension at the metatarsophalangeal joints, and the exact amount of flexion at these joints was hard to determine because of oedema of the dorsum of the foot, following capsulotomy of the knee joint. The toes could be manually flexed, a movement not previously allowed.

On August 25, 1936, resection of the motor branch of the right lateral plantar nerve and the operative procedure on the right great toe were done. The twig to the fourth interosseous space was isolated and cut. Electrical stimulation of the nerves before resection gave no movement of the toes. The wounds healed normally. On September 11, 1936, manipulation of the right foot was done. The toes were brought into neutral position after each joint of the toes had been separately manipulated. Many adhesions were heard snapping. It was difficult to correct the flexion contracture of the second and third toes at the metatarsophalangeal joints. The great toe was also manipulated. The foot was brought into 85 degrees of dorsiflexion. The left foot needed no operative procedure.

The patient was then transferred to a city hospital and later to a convalescent home in Connecticut where he was last seen on October 17, 1937. The follow-up period of about fourteen months is a sufficient length of time to estimate the end result.

In view of the joint contractures, it was not expected that a complete reversal of position could take place, and this was indicated by the test of novocain injection. The operative procedure could not interrupt the nerve supply to the first lumbricalis or to the flexor hallucis brevis, nor could it affect the deep peroneal supply of the first and second interossei dorsales. It took a certain length of time for the alteration of position of the toes to be brought about in the presence of fixed contracture of the toes. It reached its maximum after manipulation of the toes, which loosened up the joints enough for moderate reversal of position.

The right foot is still held in equinus of 120 degrees. The scars on the sole of the foot healed normally and are not painful on weight-bearing. The position of the toes is greatly improved. The fourth and fifth toes show slight flexion of the interphalangeal joints and neutral position at the metatarsophalangeal joints. The second and third toes are still slightly extended at the interphalangeal joints and slightly flexed at the metatarsophalangeal joints. The toes are still stiff and somewhat tender on manipulation. A limited amount of motion, not exceeding 5 to 10 degrees, is allowed. The great toe shows better position. There is flexion at the metatarsophalangeal joint of 165 to 170 degrees, and the interphalangeal joint is in 185 degrees of extension. The patient can walk with braces and crutches for at least half a block. The correction of the equinus deformity of the foot, proper adjustment of the braces, and training in crutch walking should increase his ability to walk.

# THE RÔLE OF THE DISCUS ARTICULARIS IN COLLES' FRACTURE

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## ANATOMY

The function of pronation and supination of the forearm is of enormous importance, and its loss or impairment causes grave disability. The ulna plays a purely passive rôle in this motion, serving as a fixed point about which the radius moves. The proximal and distal radio-ulnar joints which are concerned not only must permit the full range of motion, but also must maintain the bones in secure apposition throughout this range. Proximally this purpose is served by the cylindrical end of the radius securely held to the ulna by the annular ligament which is attached to the anterior and posterior margins of the lesser sigmoid articular concavity. At the distal end, the roughly quadrilateral radius presents on its mesial aspect a smooth concave surface for articulation with the ulna. The ulna presents a cylindrical articular surface for about two-thirds of its circumference (Fig. 1). This articulates smoothly with the lower end of the radius throughout the full range of its motion. The security of this joint is assured by the discus articularis, or triangular ligament. This structure lies between the head of the ulna and the proximal row of the carpus as a thick, fan-shaped, fibrocartilaginous plate, attached by its apex to the depression at the base of the ulnar styloid. From this point the fibers fan out to become attached to the curved sigmoid edge of the radius. It should be noted that the sigmoid surface forms an arc facing medially and that the motion of the radius about the ulna follows the prolongation of this arc. The locus of points equidistant from this arc—namely, the center of the circle of which the arc forms a part—is represented by the point of attachment of the discus articularis to the ulna (Fig. 1). Thus in the normal wrist this ligament remains tense in any position of the joint. Other ligaments, notably the capsular ligaments and the ligaments of the wrist joint itself, undoubtedly strengthen the

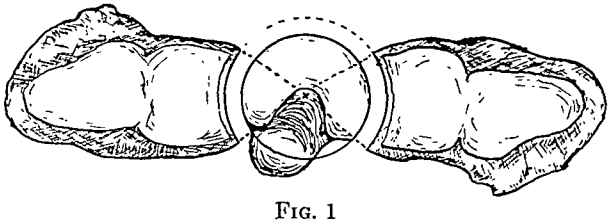


FIG. 1

Distal end of ulna and radius in pronation (left) and supination (right). Note the arc of motion of the radius about the ulnar head. The point of attachment of the discus articularis ($x$) is at the center of the circle of which the arc forms a part. From this point the fibers of the ligament fan out radially to attach to the edge of the sigmoid cavity, as shown by the dotted lines.

joint at various points of its motion, notably at the extremes, although obviously they must be lax enough to permit the full range of motion to take place. The discus articularis is unique in stabilizing the joint in any position whatsoever. The distal surface of the ulna is covered with articular cartilage to permit the ligament to glide over it. The carpal surface of the ligament prolongs the articular surface of the distal end of the radius for articulation with the proximal row of the carpus in the wrist joint.

## COLLES' FRACTURE

It is probable that the discus articularis suffers some damage in any injury severe enough to result in a fracture of the distal end of the radius. In most instances, the degree of injury to the ligament does not destroy its function of maintaining the integrity of the radio-ulnar joint. In certain more severe fractures, the ligament may be ruptured, or avulsed from its attachment to the radius or ulna, with or without a fragment of bone (Fig. 2). It is our contention that the successful management of Colles' fracture is in large part dependent on the integrity of the radio-ulnar joint, which in turn depends upon an intact discus articularis. In considering treatment, we find it helpful to divide our group of Colles' fractures into two main classifications:

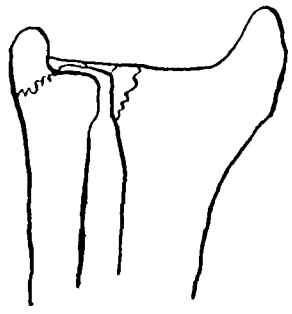


FIG. 2

Anteroposterior view of both bones at the wrist, showing the attachments of the discus articularis. Note that fractures occurring through the base of the ulnar styloid or through the medial aspect of the radius permit loss of integrity of the radio-ulnar joint. This may also occur through rupture or avulsion of the ligament without an attached bone fragment.

1. Fractures with the discus articularis intact.
2. Fractures with loss of integrity of the radio-ulnar joint, due to:
   a. Rupture of the ligament itself.
   b. Avulsion of the ulnar styloid at its base.
   c. Severe comminution of the lower end of the radius with the ligament attached to a loose minor medial fragment.

In the first group, despite displacement, comminution, and impaction, the problem is a relatively simple one. The intact radio-ulnar joint serves as a fixed point around which to reconstruct the normal anatomy. In the second group, the distal fragment moves with the carpal bones as one unit, while both bones of the forearm move as another unit and with little relation to each other. A proper reduction and fixation under such conditions becomes a complicated problem for there is no fixed point around which to build either the reduction or the fixation. It is with this second group of cases that we are here concerned. While recognition of the complicating injury may be difficult, proper treatment of the fracture depends upon distinguishing these cases.

## DIAGNOSIS

The typical deformity of Colles' fracture involves some degree of supination of the distal radial fragment in relation to the shaft of the bone. This in itself is responsible for the loss of the dorsal prominence of the ulna which is present in the normal wrist in pronation. If the integrity of the radio-ulnar joint has been lost, the ulnar head lies much farther forward, even presenting as a bulge on the volar aspect of the wrist. In addition, it will be found to be abnormally movable in relation to the radius and to the hand. It also often presents as a distinct prominence on the medial aspect of the wrist, where it is responsible for the abnormal broadening which is characteristic of the severer fractures. Marked forward or medial displacement of the ulnar head, combined with abnormal mobility, is the chief clinical evidence of a loss of the joint integrity. In addition, there is more pain on attempt to carry out pronation and supination than in the case of a simple Colles' fracture. Roentgenographic evidence confirms the separation of the ulnar head from its relation with the distal radial fragment, and a lateral view usually shows the marked forward displacement of the head. In the diagnosis of simple rupture of the ligament uncomplicated by fracture—a very rare injury—it may be necessary to take roentgenograms at various positions of pronation and supination to reveal the separation. Roentgenographic evidence of fracture through the base of the ulnar styloid, or of separation of a medial fragment of the radius (Fig. 2) is also confirmatory of loss of joint integrity. The importance of recognition of this complicating injury cannot be overemphasized.

## TREATMENT

Prompt accurate restoration of normal anatomical relationships is very important. We believe that reduction should be carried out under the fluoroscope, with general anaesthesia. Unless there is a definite contra-indication to ether, we do not advise the use of novocain in these more complicated cases. Special attention must be paid to breaking up the impaction, restoration of the proper length and articular angle of the radius, and restoration of the dorsal position of the ulna.

At the same time, the ulna must be brought into close apposition to the radius to prevent widening of the wrist. The most stable position for fixation is that of palmar flexion with extreme pronation and ulnar deviation, the so-called Cotton-Loder position. If the ulna has been properly restored to its dorsal position, this manoeuver wedges the hamate partly beneath the distal ulna, and prevents forward luxation. This then gives stability to the ulnar side of the wrist; and further palmar flexion, pronation, and ulnar deviation put traction through the carpal ligaments on the radial fragments, lifting them into place and using the wedged ulna as a fulcrum. Continuance of ulnar deviation serves further to snug the radius up to the ulna and to permit reparative processes to reconstruct the ligamentary attachments. Maintenance of the position is greatly facilitated by immobilization of the elbow, which prevents any possibility of

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*(Continued on page 15 following Current Literature)*

# OSSIFICATION OF THE TENDO ACHILLIS

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Ossification of the tendo achillis is a definite, yet rare, clinical entity. Usually the ossification results from heterotopic bone formation arising within the body of the tendon; sometimes it develops from the periosteum of the os calcis. As far as the writer has been able to determine, only twenty-one cases have been reported in the literature. The various authors offer many possible explanations of this phenomenon. It is suggested that the ossification may be: (1) an embryonic rest or inborn anomaly; (2) a neoplastic growth; (3) a sesamoid bone such as is found in the tendons of birds; (4) osteogenesis from osteoblasts circulating in the blood stream; (5) growth of bone from a torn or injured periosteum; (6) chronic infection; (7) trophic disturbance due to tabes dorsalis; (8) bone formation by fibroblasts which have taken over a bone-forming function; (9) bone formation by osteoblasts which have metamorphosed from fibroblasts.

Sixteen of the twenty-one patients whose cases have been reported were males and five were females. In eighteen cases the new bone apparently developed free in the body of the tendon. In three it was thought to have been an outgrowth from the calcaneum. Seven patients gave a history of definite injury, such as a blow on the heel or a sprain of the tendon. Five gave a history of club-foot; four of these patients had had a tenotomy of the Achilles tendon and one a resection of the plantar fascia. Two cases were attributed to injury to the periosteum of the calcaneum at the point of the insertion of the tendon, due in one case to the wearing of high-heeled shoes and in the other to stiff counters on the shoes. In one case syphilis was blamed; in another, tabes dorsalis. In one case there had been an old osteomyelitis of the calcaneum; and in another, an abscess of the gastrocnemius. In three cases no apparent cause existed. In only one of the reported cases was there a rupture of the tendon.

When the ossification is due to outgrowths from the calcaneum, it is analogous to traumatic myositis ossificans and may be termed "tendonitis ossificans traumatica". A great deal of experimental work has been done and many clinical observations have been made in an effort to explain heterotopic bone formation, but there is no agreement as to the exact mechanism of this phenomenon. Leriche feels that it is a simple process and states that it originates with an injury or tear in the tendon. Hemorrhage follows, and later calcification of this necrotic area results. This calcification stimulates the fibroblasts to form bone. Huggins demonstrated that the epithelium of the urinary bladder stimulates certain fibroblasts to form bone. He does not believe that intermediate calcifica-

supination. Acute palmar flexion alone, without pronation and ulnar deviation, will not suffice to maintain reduction in many instances, for slipping of fragments may occur. Fixation in the desired position is secured by a plaster-of-Paris cylinder or preferably by the so-called sugar-tong splint made of a single strip of plaster.

This extreme position of reduction should not be maintained for more than ten days, after which the wrist should be restored to a neutral position and safeguarded with simple molded splints for another ten days.

After-care and physiotherapy are carried out in this type of fracture essentially as they are in the less complicated type. Disability usually lasts for about two months.

## LATE CASES

A considerable number of cases of Colles' fracture are treated without recognition of this complicating factor of loss of integrity of the radio-ulnar joint. These cases account for most of the poor end results seen after this fracture. Shortening of the radius and the backward tilt of its carpal articular surface are usually due to failure to break up the impaction completely. The broad wrist and loss of the dorsal prominence of the ulnar head are due to failure to restore the ulna to its proper position in the reduction. Limitation of motion occurs chiefly in pronation and supination, and this motion is likely to be painful and is sometimes accompanied with a jog or even an audible click. There is usually tenderness over the ulnar head or the ulnar collateral carpal ligaments, and the patient is likely to refer pain to these areas. In the extreme cases the ulnar head presents marked abnormal mobility, in some positions appearing as a dorsal prominence and again medially or anteriorly. If the ulnar head is grasped, it can be found to be freely movable in relation to the radius and to the hand.

In some instances simple osteotomy to restore the radius to its proper position is sufficient to relieve the patient of his disabling symptoms[1]. More often and more effectively, subperiosteal resection of the distal end of the ulna is employed as described by Darrach, and Cotton and Morrison.

## SUMMARY

The function of the discus articularis is to stabilize the inferior radio-ulnar joint.

This ligament may be injured in Colles' fracture.

This complication requires a different technique of reduction and immobilization.

Failure to recognize the injury definitely jeopardizes a favorable prognosis.

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2. Cotton, F. J., and Morrison, G. M.: Resection of the Lower End of the Ulna (Subperiosteal). New England J. Med., CCXI, 170, 1934.
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the rather strenuous duties of a railroad trainman. He complained some of pain in the heel for about a year after the operation. At that time the repair seemed strong and the lift on the heel was discarded. Examination in November 1936 revealed slight tenderness and induration about the region of the tendon, but there was no evidence of weakness, or of impaired function, or of defect in the tendon.

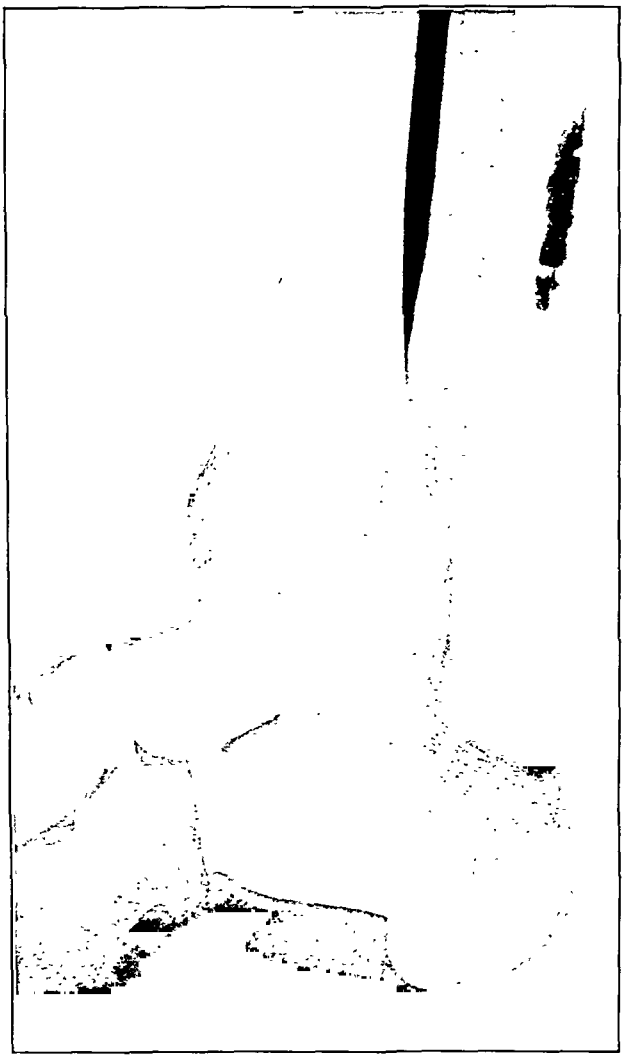


FIG. 1

This case is undoubtedly one of heterotopic bone formation of the tendo achillis. The cause of that ossification is uncertain. Possibly the patient may have torn the fibers of the tendo achillis eleven years previously when he fractured the right os calcis, although there is no history of such an injury. The fact that he has a deficiency of the neural arch of the first sacral segment makes one consider that the ossification in the Achilles tendon may be an associated congenital phenomenon.

## ABSTRACTS OF REPORTED CASES

*Höring.* The patient was a man, fifty-six years old, roentgenographic examination of whom showed evidence of two shadows in the left Achilles tendon. This was thought to have been caused by the patient's striking the heel on a hard object almost a year previously, as he had had pain in that heel almost constantly since that time. There was some bone formation in the right Achilles tendon, although there had been no injury there. The mass removed from the left Achilles tendon showed some cartilage and some spongy bone. Höring termed this condition "tendon-

tion is necessary; he also differs with Leriche in that he feels that an osteoblast is a specific type of cell. Jones and Roberts state that the osteoblast is simply a fibroblast enlarged because it is active, and that bone will be formed at any point where there is excess calcium, provided that there is an adequate blood supply. It is obvious, then, that the exact mechanism of this ossification is not clear.

Treatment of this condition is not difficult. If no symptoms are present, no operative procedure is necessary. If pain is found, operative removal of the ossification is desirable. In cases of rupture of the tendon, suture of the tendon is necessary with or without removal of the ossified area.

## CASE REPORT

N. M., white male, aged forty-two years, a railroad trainman, had been in the hospital on two occasions previous to the present accident. He had been hospitalized for two days in 1922 for treatment of an urethral stricture which was thought not to be gonorrhoeal. Routine roentgenograms of the kidneys were negative, but a deficiency of the neural arch of the first sacral segment was noted. Several months later the patient had been in the hospital again because of a fracture of the right os calcis. He had fallen from the top of a slowly moving boxcar and had landed on the tracks twelve feet below. There was little or no displacement of the fragments, and a cast was applied without anaesthesia. At that time there was no complaint of injury to the left foot or ankle. The patient had returned to work after four months entirely well.

On August 15, 1933, the patient was at his work, running along a stone-ballasted track to throw a switch, when he felt something snap in the left heel. He had not turned the ankle and was at a loss to explain the cause of his trouble. He did not fall and was able to continue on his way, but he could not rise on the toes of this foot. He was seen by the writer within a few hours, and inspection of the left ankle revealed moderate swelling and a definitely perceptible break in the continuity of the tendo achillis about two inches above its attachment to the calcaneum. Palpation revealed considerable tenderness in this area, and a forefinger placed across the back of the heel fitted deeply into the defect.

Roentgenographic examination of the left foot (Fig. 1) revealed an area of ossification in the region of the tendon, about three inches long and three-fourths of an inch in diameter, the lower end of the ossified area being three inches above the insertion of the tendon into the calcaneum. Roentgenograms of the tendo achillis of the right foot showed no ossification. Fourteen hours after the accident, an open operation was performed. There was a marked subacute inflammatory reaction in the tendon and the tendon sheath, the two being generally adherent but separable by blunt dissection. The tendon was separated for a distance of about one-half an inch at a point approximately two inches above the calcaneum. Palpation of the tendon above the point of separation and in the area of opacity, as demonstrated by the roentgenogram, revealed an indurated bony mass. It was impossible to penetrate into it with a suture needle. The break in the tendon had occurred about one-half an inch below the ossified section. For some distance on either side of the break the tendon was very necrotic and friable, and histological examination of a section removed showed necrotic tendon tissue with considerable hemorrhage and a slight acute inflammatory reaction. The defect was sutured with kangaroo tendon, and the wound was closed with catgut. A plaster cast was applied with the foot in the plantar-flexed position, and ten days later the patient left the hospital on crutches. The cast was removed after seven weeks, and the patient began to get about without crutches, but with a three-fourths-inch lift on the heel of the left shoe. He returned to his regular work after four months and has remained there, doing

where in the body. Since the patient was having little or no trouble with the heel, no operation was performed. Haglund stated that, since tendon tissue is phylogenetically the same as muscle tissue, ossification may develop there as easily as it can in muscles.

*Pinard, Vernier, and Abricosof.* Their patient had a large osteophyte in the left Achilles tendon. He also exhibited a partial positive Wassermann reaction, and the authors felt that the ossification in the Achilles tendon was associated with the syphilis.

*Koehnlein.* The patient was a man of fifty-five years, who, at some earlier time, had had osteomyelitis of the right calcaneum. Two areas of bone formation were present in the Achilles tendon,—one, three and four-tenths by one and four-tenths centimeters, beginning at the calcaneum; and another above this, two and two-tenths centimeters by six-tenths of a centimeter. This author discusses in some detail the possible causes of this condition, mentioning especially tumor, periosteal outgrowth, inborn anomaly, and aperiosteal metaplasia. He is inclined to believe that the last named is the proper explanation and states that it is not important whether the cells which form the bone are osteoblasts or fibroblasts, as they both come from the same embryonic tissue originally.

*Patel.* The patient was a sixteen-year-old girl who had been seen six months previously because of hard swellings on both of the heels. They had appeared some time before without known cause. They were sufficiently painful to interfere with walking. The tumefactions were adherent to the upper edge of the posterior surface of the calcaneum. The swellings on the right were the size of a nut and on the left they were somewhat smaller. Roentgenographic examination showed no shadows. These nodules were removed and were found to be bone. The author felt that they were not sufficiently ossified to show in the roentgenogram. He believed that the osteomata had developed because of traction or pressure at the insertion of the Achilles tendon, due to the wearing of extremely high-heeled shoes. He thought the periosteum had been torn or irritated.

*Berard* (reported in the discussion of the case of Patel). The patient was a woman of thirty-eight years who had had pain in the heel for some two years. Examination showed a column of bone, two centimeters in length, arising at the posterior apophysis of the calcaneum and extending into the Achilles tendon. The author regarded this to be an osteoma caused by irritation or tearing of the periosteum. He thought the hard counters on the shoes might have started the trouble.

*Chevalier.* The patient was a woman, seventy-eight years old, who had come to the hospital because of an abscess on the top of the left foot. Examination showed a painless indurated mass in the left tendo achillis, and roentgenograms revealed an ossified mass at this site, three or four centimeters long. Since this condition did not trouble the patient, no operation was considered. The author felt that this was some sort of trophic disturbance and that it was not due to periosteal injury.

*Sainton and Péron.* The patient was sixty years old and suffered

itis ossificans traumatica" and regarded it as similar to myositis ossificans traumatica.

*Painter and Clark.* The authors reported two cases. The first was that of a man of thirty-eight years, who had caught the left foot between two bales of cotton four months previously. Two nodules developed in the tendon soon after. The tendon was incised and the two nodules were removed. Their second case was that of a man of fifty-one years, who had had stiffness in the cord of the right heel for five years. He regarded it as "rheumatism", although there was marked atrophy of the calf, resulting from an old inflammatory process which had destroyed the gastrocnemius muscle. Operative treatment was not warranted. These authors regarded the condition as similar to myositis ossificans.

*Jacobsthal.* The patient was a man, sixty years of age, who had bilateral congenital club-foot. Because of this condition the plantar fascia had been resected when he was one year old. He had been having pain in the heels during the past five years, this pain having come on gradually without known cause. Roentgenograms showed a bone formation in the left Achilles tendon, four by nine centimeters in dimension, and one in the right tendon, measuring one by five centimeters. Neither mass was attached to the calcaneum. The author attributed the ossification to the tenotomy.

*Meyer.* The patient was a man who had injured his foot four years previously. Apparently a traumatic pes equinus had developed for which a tenotomy of the Achilles tendon had been performed. Immediately before he was seen by Meyer, he had suffered a slight injury to the heel, which caused pain and swelling. Roentgenograms showed a shadow which was regarded as either ossification or calcification, probably the former. The area was several inches long and was not attached to the calcaneum. Meyer thought that a hematoma had developed in the tendon at the time of the tenotomy, which had become calcified and later ossified.

*Sundt* (cited by Mazzini, Reyes, and Monzo). This case is one of calcification or ossification in the tendo achillis of a boy, nine and one-half years old.

*Steiger.* The patient was a woman, thirty-three years old, whose illness had begun when she was twelve years old. A small indurated swelling developed on the heel. Roentgenograms demonstrated an ossified area which was not attached to the calcaneum It was removed by open operation.

*Haglund.* This patient was a man, sixty-seven years old, who was seen because of disability of the left foot. He recalled that as a youth he had cut the heel on a scythe, but he could remember no other injury. Four months previously, acute pain and swelling had developed in the heel, which he regarded as "rheumatism". Roentgenographic examination demonstrated a shadow in the tendon. There was no shadow in the tendon of the other foot, nor was any abnormal ossification found else-

showed the ossification. No operation or microscopic studies were possible. This author compared this bone formation to that in tendons of birds.

*Jones and Roberts.* The patient had had a tenotomy of the Achilles tendon twenty years previously. Roentgenographic examination showed an extensive calcification in the tendon, beginning a short distance above the calcaneum and extending high into the calf. There was also a calcification of the supraspinatus tendon. These authors believed that the ossification of the tendo achillis was one of true heterotopic bone formation and that it followed the tenotomy. He stated that a calcareous deposit would naturally develop in the fibrotic area of the tendon because of its decreased vascularity. Ossification would follow the calcification in the manner described by Leriche. They stated that this is a quite different process from the ossification due to an avulsion of the periosteum of the calcaneum, the latter condition being similar to myositis ossificans.

*Mazzini, Reyes, and Monzo.* These authors reported two cases. The first case was that of a man of seventy-six years, who had been losing strength in the lower extremities for the past three or four years. In addition, he had other symptoms suggestive of a deficient circulation in the lower extremities. He also had some muscular rigidity, so that he walked on the outer borders of the feet. Examination showed marked muscle atrophy and coldness of both lower extremities. The roentgenogram showed an ossified mass, nine centimeters long, in the right Achilles tendon and another, eleven centimeters long, in the left Achilles tendon. The latter tendon had a break in the continuity as though it were fractured. The masses were not attached to the calcaneum. The second case was that of a man, forty-three years of age, who, several years previously, had injured the left foot while getting out of a wagon. He had caught this foot in a cable which was charged with electricity and he had suffered a severe local injury. Examination showed some discoloration of the left leg, as well as some oedema and venous engorgement. Roentgenograms disclosed an ossified area, seven centimeters long, which seemed to have been fractured. In addition to reporting these two cases, these authors summarized fifteen previously reported cases and listed the various explanations which have been offered for this ossification.

NOTE: Since this article was written, another case of ossification of the Achilles tendon has been reported by Hufnagl.

## SUMMARY

1. In some cases of ossification of the tendo achillis, the ossification arises from the calcaneum and is of periosteal origin. In other cases, the bone arises in the midst of the tendon. In spite of a great deal of experimental work and many clinical observations, the exact mechanism of this ossification is not clear.

2. The possibility that in some cases this condition is due to congenital defect should still be considered. Four of the cases reported

from tabes dorsalis. Routine examination showed the swelling in the heel, and roentgenograms disclosed an ossification in the tendo achillis, which was not attached to the calcaneum. The patient had no pain in the heel, and no operation was performed. These authors felt that the ossification was a trophic disturbance and was associated with the tabes dorsalis.

*Mallinson.* The patient was fifty-six years old and had been born with a bilateral talipes equinus. At eight years of age, a bilateral subcutaneous tenotomy had been performed. The patient was able to get about without a great deal of difficulty, but one day, while at work, he felt a sudden sensation in the left heel as though he had been struck a heavy blow. Roentgenographic examination revealed bilateral ossification of the tendo achillis, with fracture of the left. Open operation was performed, and the fragments were sutured with silver wire. Afterwards this patient got about with a three-fourths-inch lift on the left heel. The author mentioned the introduction of chronic infection at the time of the original operation as a possible cause of this condition. He also stated that it might have been due to excessive strain of the tendons or possibly to metabolic error or vitamin deficiency.

*Volkmann.* The patient was a woman, sixty-three years old. There had developed on the back of the left heel what she regarded as a blister. She did not know what the cause of this was, but it gave her considerable pain and made her limp. Roentgenographic examination showed a spur on the calcaneum and also two ossified areas in the Achilles tendon, the lower one apparently being attached to the calcaneum. There was also a small bony formation at the attachment of the right Achilles tendon. The osseous bodies were removed by open operation. The author stated that this condition is similar to the so-called myositis ossificans and that it may be spontaneous, traumatic, or similar to the bony tendons found in birds. He regarded this case as being traumatic and due to chronic irritation because of painful walking due to the heel spurs. He believed that the ossification followed the deposition of calcium in the injured tendon.

*Scherb* (cited by Volkmann). The patient was a man, forty-nine years old, who had fractured the left femur twenty-seven years previously. One year before hospital admission he had refractured the femur and had also fractured a metatarsal bone. Examination showed complete fixation of the subastragalar joint and a talipes equinus. The Achilles tendon was lengthened, and a small section of the bony tissue was removed. Microscopic examination showed spongy bone as well as areas of calcification and cartilage, the central part of the body being fibrous.

*Densow* (cited by Volkmann). A man, thirty-nine years old, had struck the back of the left heel on a hard object thirteen years previously. An indurated swelling had developed, but it had given the patient little trouble. He came into the hospital because of an axillary adenitis; routine examination revealed the swelling in the left heel and roentgenograms

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showed a congenital talipes. The case which the author has reported showed a congenital defect in the neural arch of the first sacral segment.

The writer wishes to thank Miss Maude E. Nesbit and her associates at the New York State Medical Library for their help in connection with the bibliography.

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VOLKMANN, J.: Über Verknöcherungen in der Achillessehne. Ztschr. f. orthop. Chir., LX, 110, 1933.

# INTRA-ARTICULAR DISPLACEMENT OF THE INTERNAL EPICONDYLE FOLLOWING DISLOCATION

BY ALEXANDER P. AITKEN, M.D., F.A.C.S., BOSTON, MASSACHUSETTS, AND HAROLD M. CHILDRESS, A.B., M.D., DALLAS, TEXAS

Although the subject has been described by others, the frequency with which the internal epicondylar epiphysis is displaced into the joint following dislocation of the elbow, especially in childhood, has not been fully recognized. Within the last ten months six such cases have been seen by the authors. The danger of this complication lies not only in the loss of motion of the elbow joint but also in the great possibility of permanent damage to the ulnar nerve. Two of our patients entered the hospital because of such paralysis.

The medial epicondyle is a rounded prominent projection of the distal humerus. Lying outside the joint capsule, it has a separate epiphysis which appears at the fifth year and fuses at the eighteenth. It serves as the common origin of the flexor group of forearm muscles and as the attachment of the anterior and posterior portions of the ulnar collateral ligament of the capsule. The ulnar nerve lies in a shallow groove on the pos-



FIG. 1-A FIG. 1-B

Posterolateral dislocation of the elbow. Note the epiphysis of the internal epicondyle lying directly over the olecranon fossa in the lateral view and between the shaft and ulna in the anteroposterior view.

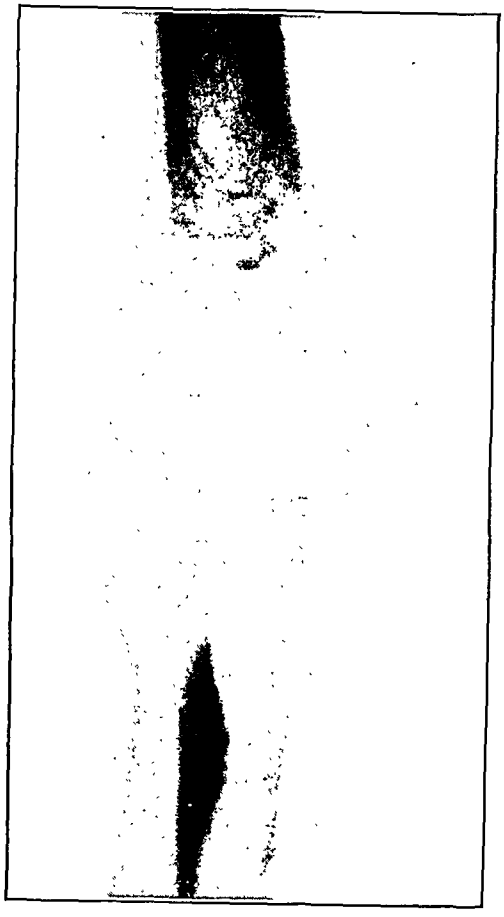


FIG. 2-A

Right elbow (normal). Note the relationship of the epiphysis to the shaft and the width of the normal joint space.

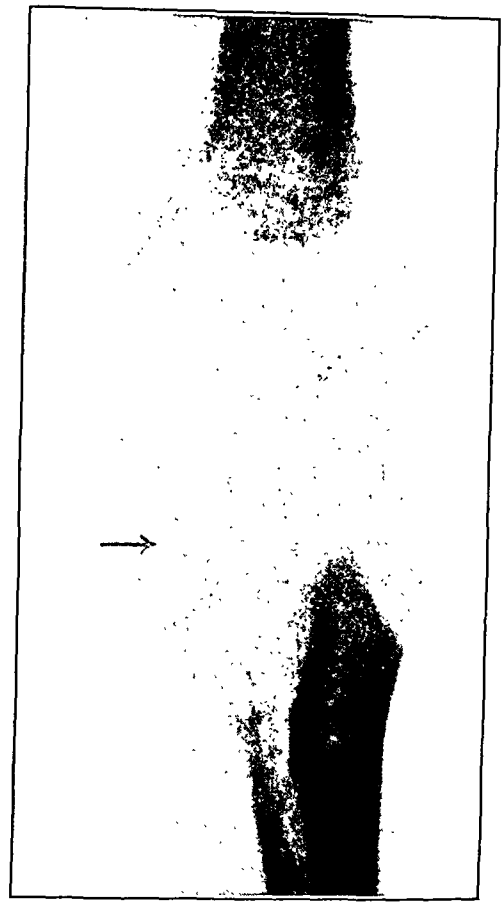


FIG. 2-B

Left elbow. Note the epiphysis of the internal epicondyle lying in the elbow joint, and the increase in width of the joint space.

terior surface of the epicondyle and is attached to it by fascial bands. Distal to the epicondyle the nerve enters the flexor muscles a short distance below their insertion to the epicondyle.

A fall upon the hand, with the forearm abducted and the elbow slightly flexed, is apt to cause posterior or posterolateral dislocation of the elbow. Such a fall also exerts a pull upon the common flexor tendon and the ulnar collateral ligament, both of which are attached to the internal epicondyle. As a result, an avulsion of the epicondyle at the epiphysis occurs. The fragment is then pulled downward and forward by the flexors. The entire fragment, free of the humerus, is then carried backward and laterally with the displaced ulna, so that it lies posterior to the trochlea and anterior to the semilunar notch of the ulna.

In the reduction the epicondyle is thus in a position either to drop into the notch or to be forced in as the humerus slides backward into the notch. The epicondyle, locked within the joint, carries with it the insertions of the flexor muscles and the ulnar nerve. The nerve is thus apt to be crushed between the bone surfaces, or, more commonly, severely stretched and constricted either by the fascial bands which bind it to the epicondyle or at



FIG. 2-C

Lateral view of right elbow (normal). Note the width of the joint space. The epicondyle can be seen through the joint space, but it is not within the joint.



FIG. 2-D

Left elbow. Note the increase in width of the joint space and the presence of the epiphysis within the joint.

the point where it enters the flexor muscles. When such a displacement occurs, immediate reduction is imperative if severe or permanent nerve damage is to be avoided. Early postreduction roentgenograms, interpreted with special attention to the position of the internal epicondyle, are the best safeguards against later nerve changes and a poor functional end result. In Figure 2-B the internal epicondyle was interpreted by two roentgenologists as an anomalous epiphysis of the olecranon. In case of doubt, it is well to x-ray both elbows in the anteroposterior and in the lateral views. The position of the epicondyle and the presence of anomalous epiphyses can then be readily determined.

## DIAGNOSIS

Reliance should be placed more upon a roentgenographic study than upon symptomatology. If the patient is seen early, palpation should reveal the absence of the medial epicondyle and even the roughened bed of the fragment. The elbow is carried in a partially flexed position. There is moderate loss of flexion, as well as marked loss of extension. There is a slight increase of the carrying angle. Most of our patients were seen

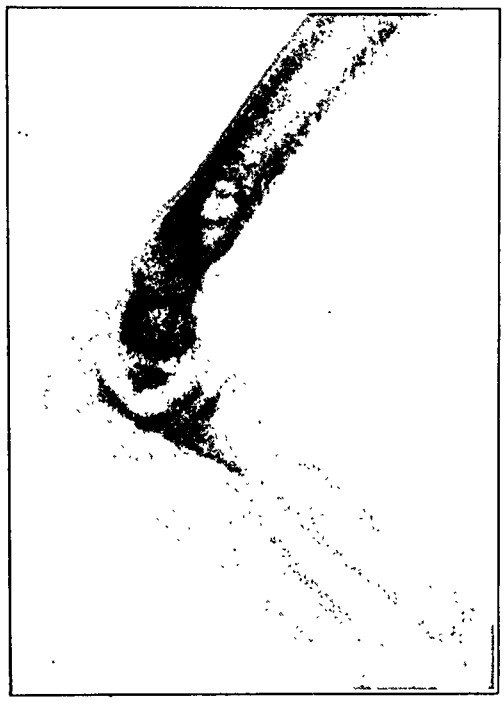


FIG. 3-A



FIG. 3-B

The epiphysis of the internal epicondyle lies within the joint. Note the increase in width of the joint space in both views.

several hours after the dislocation of the elbow had been reduced. In these cases the joints were so swollen and painful that the physical findings were of little aid in making the diagnosis.

In the roentgenograms the medial widening of the joint space with an absence of a normally situated medial epicondyle is diagnostic. (See Figures 1-A, 1-B, 2-A, 2-B, 2-C, 2-D, 3-A, 3-B, and 4.) In each of these cases the fragment was plainly seen interposed between the trochlea and the olecranon. According to other writers, this finding is not always present, especially in patients under seven years of age, at which time the medial epicondyle is mostly cartilage.

Immediate ulnar-nerve signs are usually not present unless the nerve has been subjected to excessive trauma during reduction or at the time of injury. Usually, if present, they will not be noticed by the patient unless attention is directed toward them by the examiner. After the acute reaction and pain at the elbow have subsided, the patient becomes aware of the areas of anaesthesia and muscle weakness. In the majority of cases, nerve symptoms—both sensory and motor—increase in intensity, due to the constriction produced by the fascial attachments extending from the nerve to the imprisoned epiphysis. Cotton reported three cases with definite neural signs, in one of which the nerve had been drawn into the joint and was lying alongside the avulsed fragment. Four of the five patients whose cases were studied by Wilson had ulnar-nerve paralysis of varying degrees. In our group three of the six patients had symptoms of ulnar-nerve pressure.

## TREATMENT

If the dislocation has been reduced and the fragment lies within the joint, the only treatment is immediate surgical reduction. It is not possible to manipulate the epicondyle out of the joint unless the elbow is redislocated. Although successful in this manoeuver, one may by such forced manipulation seriously injure the exposed nerve. If, however, the patient is seen before the dislocation has been reduced, it may be possible to keep the medial side of the joint open during manipulation and thus permit the fragment to escape. This did occur in one case in which roentgenograms before reduction showed the epiphysis pulled down and laterally to a position beneath the trochlea. Accidental reduction occurred while the patient, holding his injured arm at the wrist, sat down on a chair. The fragment was thrown clear and later roentgenograms showed it near its original location.

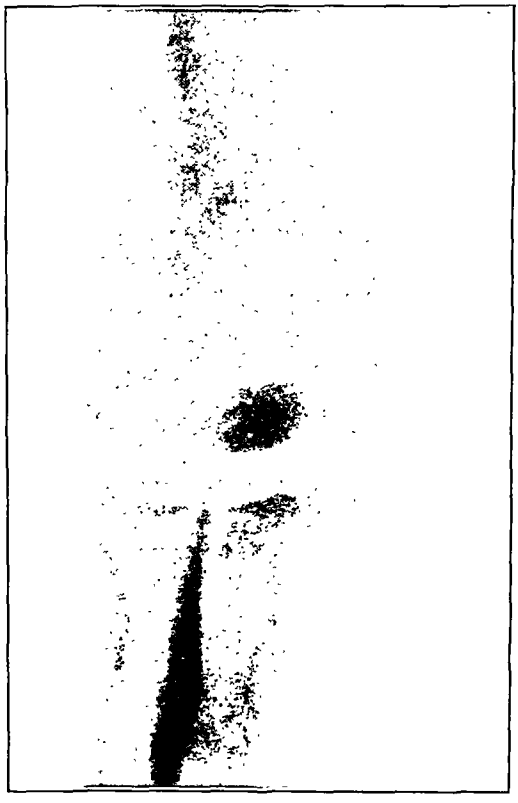


FIG. 4

The epiphysis lies within the joint.

Surgical approach to the fragment is best made through a three-inch posteromedial curved incision extending from the epicondylar bed down over the medial aspect of the joint. The nerve is found posterior to the fracture surface of the humerus and should be followed distally to the point where it enters the joint. The flexor muscles are then identified and can readily be seen to enter the joint. The forearm is then abducted at the elbow to widen the joint space medially, while a curved periosteal elevator is placed under the muscles where they enter the joint. By traction on the muscles by means of the elevator, the fragment is easily reduced. A full range of motion should follow.

The fragment may be excised or reattached. In either case the common flexor tendon is sutured either to the periosteum or to the humerus through a drill hole. Fixation may be performed by means of a nail. As the epiphysis in question contributes only to the growth of the epicondyle, growth disturbance because of excision or internal fixation is of no clinical importance.

In all cases it is well to transpose the ulnar nerve anteriorly. This is done to prevent further damage to the nerve either by rubbing over the roughened epicondylar bed of the humerus or by becoming caught in the fibrous tissue during healing of the fracture.

Following operation, the arm is immobilized in flexion with pronation of the forearm either in a sling or in a posterior plaster shell. Motion may be started in from three to four weeks.

## SUMMARY

1. Intra-articular displacement of the internal epicondylar epiphysis may complicate elbow dislocations in children with injury to the ulnar nerve.

2. Postreduction roentgenograms of all elbow dislocations should be taken to rule out this complication.

3. Immediate surgical reduction is the best course, although closed reduction is possible if the medial joint space is widened during manipulation.

4. Anterior transplantation of the ulnar nerve is advisable whether the epicondyle is excised or reattached.

5. An excellent end result may be expected if the condition is treated promptly and correctly.

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# THE USE OF AMNIOTIC-FLUID CONCENTRATE IN ORTHOPAEDIC CONDITIONS *

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In 1927 Johnson reported on the use of human and bovine amniotic fluid as an agent which would stimulate the defense mechanism of the peritoneum. The human amniotic fluid obtained at cesarean section was at first employed, but later a concentrate prepared from bovine amniotic fluid was substituted. Considerable literature exists regarding the use of this concentrate within the abdomen. It shows that the introduction of the concentrate within the peritoneal space excites the early production of a defense exudate; that it produces a reaction simulating the normal process of repair; and that it inhibits the development of a dangerous peritonitis.[9] There is also some evidence to show that its use prevents, or at least minimizes, postoperative adhesions.[7, 12, 13] Personal experience in the use of this concentrate within the abdomen is in agreement with these conclusions.

Three years ago the thought occurred to the author that, if the amniotic concentrate was effective in hastening the process of repair within the peritoneum, it ought to be of value in other serous cavities, including those of the body joints. Therefore, a study of the use of amniotic-fluid concentrate within the joints under varying conditions has been made. This report is the result of that study.

The composition of amniotic fluid[17] is that of a hypotonic liquid, with a specific gravity never above 1.010. It contains coagulable albumin, cholesterol, histidine, lysin, allantoin, certain inorganic compounds, and varying amounts of mucin. The work of Cantarow, Stuckert, and Davis shows that the fluid is not urine or a serum dialysate, but a true product of the amniotic cells.

There was used in the work upon which this report is based an amniotic concentrate now on the market. This product is obtained by concentrating, fractionating, and purifying the amniotic fluid of cows which are from two to four months pregnant. At this period of bovine gestation, it is unlikely that contamination of the fluid would occur, and, unlike the human foetus, there is no possibility of urine contamination from the calf.[6]

It is of importance to know that Johnson demonstrated that this fluid is harmless when injected intraperitoneally.[5] In this work no ill effects have followed its use in the joints. The concentrate employed is

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superior to the whole amniotic fluid because in its preparation the protein content is reduced, and it is rendered sterile and stable.

## CLINICAL APPLICATION

The total number of cases in which the concentrate was used within joint cavities was sixty-eight. These cases may be classified as follows:

| *Types of Cases* | *No. of Cases* |
|---|---|
| Arthrotomies (clean) | 26 |
| Closed manipulation of joints | 12 |
| Fractures involving joints | 8 |
| Fractures adjacent to joints | 7 |
| Joint effusion (etiology unknown) | 4 |
| Joint effusion (gonorrhoeal) | 1 |
| *Atrophic arthritis* | 8 |
| Sympathetic joint effusion | 1 |
| Subacute joint infection | 1 |

There were twelve cases in which amniotic concentrate was used on tissues outside of joints.

The joints in which amniotic concentrate was used were as follows:

| *Joint* | *No. of Cases* |
|---|---|
| Knee | 46 |
| Shoulder | 8 |
| Elbow | 6 |
| Hip | 5 |
| Ankle | 2 |
| Wrist | 1 |

## ARTHROTOMIES (CLEAN)

For some time past the procedure of introducing amniotic concentrate into all joints after intra-articular surgery has been employed.

*Technique:* After the necessary surgery has been completed, a moderate-caliber needle is introduced well into the joint space, and the joint is completely closed around the needle; this includes skin closure. The concentrate is then introduced in sufficient amount to distend the joint cavity with the fluid. This requires varying amounts of the liquid. In the knee joint as much as 100 cubic centimeters has been injected. The amount used varies with the individual joint. Enough fluid is introduced to cause separation, even if minimal, of the articulating surfaces.

Warren has demonstrated experimentally that the absorption of the concentrate within the peritoneal cavity proceeds as follows: The fluid introduced drops in content one-half during the first four hours; there is 15 per cent. left at the end of twenty-four hours; and it has completely disappeared within forty-eight hours. It is believed that the rate of absorption within joints is somewhat slower. The concentrate is absorbed rapidly at first, but at least 25 per cent. remains at the end of twenty-four hours, and it may be as long as sixty hours before complete absorption has taken place.

Warren has also made the interesting observation that the period of

oozing of a traumatized peritoneum is reduced by half when the amniotic fluid is employed. A similar action takes place on injection of the concentrate into a joint cavity, and this is a factor of prime importance in intra-articular surgery.

Johnson, in experimental work with the concentrate in the peritoneal cavity,[8] showed that a maximum white-cell response occurred within twelve hours. He found an impressive subserous oedema with a minimal hemorrhagic response, as shown by the merely pinkish exudate. This exudate was rich in fibrin, and, if withdrawn after four hours, it jelled immediately. Later on, as the total white-cell count receded, a variable percentage of histiocytes was found.

In two cases in which joints were aspirated after the introduction of the concentrate, it was found that in one case, after four hours, the aspirated fluid jelled almost immediately, thus demonstrating its high fibrin content. The total cell count was 22,000 with 95 per cent. neutrophiles. In the second case, in which the fluid was aspirated at the end of twenty-six hours, the total count was 12,400 with 45 per cent. histiocytes. It would, therefore, seem plausible, as Johnson has pointed out, that the concentrate speeds up considerably the normal process of defense repair. Collins has shown that normal synovial fluid contains a mucin protein, and that the function of the mucin is to increase viscosity.[2] Jones has demonstrated that the function of any joint is dependent on the fluid pressure film of the synovial fluid, and that one factor in the proper maintenance of such a pressure film is the viscosity of the lubricant. Since amniotic concentrate contains mucin, it is logical that it would act as a joint lubricant.

In attempting to explain the *modus operandi* of amniotic concentrate after surgery within joints, it would be fair to state that it (1) reduces oozing time to a minimum, (2) excites a brisk defense-repair effort, (3) increases viscosity and acts as a lubricant, and (4) operates mechanically to separate traumatized joint surfaces.

Clinically it was observed in these twenty-six cases that postoperative pain was reduced to a minimum. As compared with cases in which the concentrate was not used, this difference was striking. No postoperative infection occurred in any case, but the significance of this in clean-joint surgery is slight. No postoperative adhesions occurred in any case. In all twenty-six cases the final functional result could be fairly rated as "good" to "excellent". It was found that function was more easily and rapidly restored when the concentrate was employed. In four cases it was deemed necessary to refill the joint. In nineteen cases the temperature postoperatively did not reach 100 degrees; in five cases it reached 100.2; and in two cases it went as high as 101. The systemic white count in twenty cases showed a postoperative leukocytosis of between 10,000 and 15,000. This, however, in view of the operative trauma, is of little significance. In no case was there observed a pathological effusion after surgery.

The absence of complications following twenty-six arthrotomies after using amniotic-fluid concentrate, as compared with those reported by Swett in 100 arthrotomies without its use, may or may not be significant. (See Table I.)

TABLE I

COMPARISON OF TWENTY-SIX ARTHROTOMIES AFTER USE OF AMNIOTIC-FLUID CONCENTRATE (SHIMBERG) WITH 100 ARTHROTOMIES WITHOUT ITS USE (SWETT)

| | Without Amniotic-Fluid Concentrate | Following Amniotic-Fluid Concentrate |
|---|---|---|
| Postoperative Complications: | | |
| Death | 0 cases | 0 cases |
| Infection | 0 cases | 0 cases |
| Excessive effusion | 7 cases | 0 cases |
| Adhesions and delayed return of motion | 7 cases | 0 cases |
| Manipulation to restore motion | 4 cases | 0 cases |
| Recovery Period: | | |
| Duration of bed treatment (average) | 9 days | 5 days |
| Duration of use of crutches (average) | 16 days | 11 days |
| Recovery of functional use (average) | 9.5 weeks | 4 weeks |
| End Results: | | |
| Full recovery | 95 cases | 25 cases |
| Slight remaining disability | 5 cases | 1 case |

## CLOSED MANIPULATION OF JOINTS

In these twelve cases, for one reason or another, it was deemed advisable to break down joint adhesions by manipulation under anaesthesia. Previous experience with such forcible manipulation had been unsatisfactory in that severe postoperative pain had occurred, and usually there had been a return of adhesions and disability. In these cases, after manipulative procedure, the joint in question was filled under the strictest asepsis with the concentrate. As much fluid as possible, without causing undue capsule stretching, was introduced. In joints other than the knee, technical difficulties were encountered, for most joints are difficult to enter with a needle unless an effusion is present. In the hip joint an anterolateral approach was used, the needle following the femoral head into the joint space. The shoulder joint was entered in a similar manner. A posterior approach to the elbow and wrist joints proved satisfactory. The ankle joint was entered lateral to the internal malleolus.

CASE 36. The patient, a male, aged thirty-eight, gave a history of gradual stiffening of the right shoulder with no known trauma. Roentgenographic examination was negative. Physical examination disclosed inability to abduct the shoulder beyond 45 degrees; the scapula moved simultaneously with the arm. Circumrotation was markedly limited and painful. There was no evidence of gonococcal infection. There was severe pyorrhoea. The sedimentation rate was 12.

The pyorrhoea was given adequate treatment, and, under anaesthesia (evipan), the shoulder was manipulated and dense adhesions were broken up. Twenty cubic centi-

meters of concentrate was introduced into the shoulder joint, and twenty-five cubic centimeters placed in the peri-articular tissues. The arm was superabducted and elevated when the patient returned to bed, and kept in that position for twenty-four hours. There was no complaint of excessive pain. After a period of twenty-four hours, all restraint was removed, and the patient was encouraged to move the arm as much as possible. No physiotherapy was prescribed. At first the shoulder could be moved in all planes with ease. Then there occurred a period of some stiffening, but within ten days the patient had a 90-per-cent. range of motion with but slight pain.

The patient was seen six months after discharge and stated that he had returned to his job as an automobile salesman, and that he had no trouble whatsoever with his arm. Examination did not reveal any abnormality of the shoulder.

In these cases it has not been found necessary to do a remanipulation, although in four there was administered a second injection of the concentrate after the operation. In only one case was there failure to achieve a moderately good or excellent result. The author fully agrees with the generally held opinion that in so-called idiopathic stiffening of a joint, such as the shoulder, the majority of the adhesions are extra-articular. This is the reason for the procedure of infiltrating the peri-articular structures. No untoward result from introducing the concentrate into tissues outside the joint has been observed.

### FRACTURES INVOLVING JOINTS

In this type of fracture there is considerable joint trauma with bloody effusion, and the end result, in previous experience, has been unsatisfactory in the majority of cases.

In the eight cases reported the concentrate was employed with uniformly good results.

CASE 67. A male, aged forty-two, fell from a cherry tree, sustaining a severe injury of the right knee. He was seen within a few minutes after the fall. Roentgenographic examination showed that he had a spread-eagle fracture of the tibial head with multiple fissures extending into the joint, as well as a lateral dislocation of the tibia on the femur. A considerable joint effusion was present.

Under anaesthesia, the dislocation was reduced, although there was a tendency to redislocate. Due to the spreading of the tibial head, a Carrel screw was inserted, and the fragments were brought firmly together. The joint was aspirated, and fifty cubic centimeters of very bloody fluid was removed. This was replaced by seventy-five cubic centimeters of the concentrate, and a cast was applied. There was little postoperative pain. No narcotic was required.

At the end of five weeks, the cast and the Carrel screw were removed. At this time there was 25 per cent. active motion of the knee joint. Physiotherapy in the form of diathermy, massage, and active movement was instituted. The patient resumed full work without any support at the end of eight weeks and two days, with 85 per cent. of full function. In three months the function had returned to normal.

In this case, in spite of proved severe joint trauma, there was complete healing and return of normal function within an unusually short time. Similar results have been obtained in seven other cases of varying degrees of severity, in which the knee was involved in five cases, the shoulder in one case, and the ankle in two instances. It is felt that these results lend support to the theory that the concentrate excites an early defense-

Tarso



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gonococcal infection existed. The knee had been aspirated twice before admission, but no information as to the type or amount of fluid removed was available.

The knee was aspirated soon after admission, and seventy cubic centimeters of a clear, thin, non-coagulable fluid was obtained. Its specific gravity was 1.015, and the fluid contained 1500 cells per cubic centimeter, 15 per cent. of which were neutrophiles. The joint was filled with seventy-five cubic centimeters of concentrate. After seventy-two hours there was no fluid remaining in the joint, and no return of the effusion occurred.

In the other three cases also, one filling of the concentrate was sufficient to prevent the reappearance of an effusion.

Collins states that, when the same joint is aspirated twice within a few days, there is a change in the viscosity of the fluid and the second "diluted", less viscous fluid is more amenable to natural absorption than the original effusion.[3] Whether the concentrate exerts some biological action in these cases, or whether there is a purely physical action concerned, involving surface tension and viscosity, is a matter of speculation.

### JOINT EFFUSION (GONORRHOEAL)

CASE 42. The patient was a male, aged forty-six, who for years had had trouble with the right knee, and his history showed a gonococcal background. A gonorrhoeal arthritis seemed probable, even though the bacteriological study was negative. The knee, when first seen, was swollen, painful, and slightly hot to the touch. There was no temperature rise or increased systemic white count. There was a moderate amount of fluid in the joint, and the synovial membrane was definitely thickened. The roentgenographic findings were as follows: "There are punched-out areas along the outer margin of the knee joint and a destruction of cartilage as shown by the almost complete obliteration of the inner portion of the joint space."

Aspiration of the knee was performed and ninety cubic centimeters of thick green fluid was obtained. This did not coagulate. Examination of the fluid showed a considerable number of pus cells, but no organisms. A culture was sterile. Ninety cubic centimeters of concentrate was placed in the joint. Twelve days later there was a moderate effusion in the joint. This was aspirated and fifty cubic centimeters of clear, quickly coagulable fluid was obtained. This fluid showed but few pus cells, with a total white count of 14,500 and 67 per cent. neutrophiles.

There was a definite change in the character of the fluid following the use of the concentrate. After the second injection, there was no marked accumulation of fluid within the joint. The patient stated that his knee felt better than it had for some time past, but there still remained considerable joint pathology.

### ATROPHIC ARTHRITIS

In atrophic arthritis the joint manifestations are but local outcroppings of a profound systemic disease. It is logical to assume that, even though the systemic aspects of the disease may be brought well under control, the pathology initiated in the joints, being of an inflammatory character, will go on to some degree of joint damage.

In six cases of subacute atrophic arthritis, in which there was either joint effusion or marked pathology of the synovial membrane, the concentrate was used in an effort to limit the damage. Timbrell Fisher has reported excellent results in such cases with arthrotomy and lavage with Dakin solution. In this study the knee joint was entered with a needle, and such fluid as was present was withdrawn and replaced with a larger

repair effort with resolution without adhesions, and also that it quickly seals oozing traumatized joint tissues. Jones found that the pressure film of synovial fluid could withstand a load which would crush bone. In intra-articular fractures, it is reasonable to assume that even that resistant pressure film may be broken. It is also logical to believe that the amniotic concentrate restores the pressure film, so that the lubricant effect so necessary to normal function can once more operate.

In the case cited, there existed circumstances which made continuous hospitalization impossible. Consequently, but one filling of the concentrate was made. In four other cases the filling was repeated once in three cases and twice in the remaining case. A refill within sixty hours of the first injection of the concentrate is deemed generally advisable. The case in which three fillings were made was a severe crushing of the patella with injury to the femoral patellar facet. It was a compound fracture in which open operation was performed. In spite of the devitalized condition of the tissues, after a débridement and concentrate injection, first-intention healing and an 80-per-cent. normal end result were obtained.

In this type of fairly common injury, where good end results are so difficult to obtain, and where prolonged hospitalization and treatment are so often necessary, it is believed that the use of the amniotic concentrate is of distinct value.

### FRACTURES ADJACENT TO JOINTS

In each of these seven cases there was a fracture adjacent to a joint, and, while there was no evidence of bony intra-articular injury, yet it was believed that some trauma to the joint tissues had occurred. In these cases, after reduction, a cast was applied and a window was cut over the nearby joint, through which from one to three fillings of the joint with the concentrate were made.

The functional results in these cases were excellent, and it was found that immediately after removal of the cast there was more than usual joint function. This procedure was prompted by the thought that amniotic concentrate might be of value in the treatment of closed fractures where there was reason to suspect some joint trauma.

### JOINT EFFUSION (ETIOLOGY UNKNOWN)

There are certain types of joint effusions, especially in the knee, in which there is considerable doubt about the etiology. The four cases included under this head were ones in which a joint effusion had appeared and persisted, and in which there was no known etiological factor. In all cases, the knee was involved, and, in two instances, there had been several aspirations with reappearance of the fluid. After aspiration of the existing joint fluid, the joint cavity was distended with the concentrate in each case.

CASE 4. A male negro, aged forty-six, gave a history of fairly sudden swelling of the right knee with accompanying pain. The Wassermann test was negative, but

concentrate. The temperature dropped to normal after three days. There was no further effusion and the patient recovered.

No conclusions may be drawn from this one case, but it is thought-provoking.

### THE USE OF AMNIOTIC CONCENTRATE ON OTHER THAN JOINT TISSUES

In four cases of slow-healing fractures, the concentrate was injected into the fracture site. Without a large controlled series it is impossible to evaluate the results obtained, but the clinical and roentgenographic evidence tended to show that the fluid was a stimulant of bone repair. This impression is in agreement with the experimental work of Morrison, Johnson, and Hazard. This procedure is definitely worthy of further clinical trial.

In eight other cases the amniotic fluid was used in soft tissues for various reasons. It was injected under the lumbar fascia for the forcible breaking up of adhesions. This procedure was suggested by Dr. Charles Murray Gratz of New York. As yet no decision has been reached as to its value for this purpose. It is again emphasized, however, that the use of the concentrate within soft tissues has never caused the slightest unfavorable reaction. It was used in a case of free skin graft with good results, also in two cases of moderate burns in which it appeared to have a mild anaesthetic effect. Its use in soft tissues, it is believed, might be considerably extended.

### DISCUSSION

From the evidence submitted, amniotic-fluid concentrate appears to influence favorably the mechanism of defense repair. Its composition gives but meager information upon which to formulate a theory which will satisfactorily account for its beneficent action. It is true that it contains allantoin in small amounts, and there is evidence to show that allantoin is of value in promoting repair. It is to be considered that amniotic fluid is a true body fluid, and one of its functions is to prevent adhesions between the foetus and the amniotic sac.[19] There is also reason to believe that its action is not merely mechanical, but also biological.[8] Its use within joint cavities accomplishes several purposes. First, it distends the cavity with an innocuous fluid, and this mechanical distention separates to some extent the injured surfaces. This, after all, is probably nature's reason for creating an effusion in response to trauma or irritation. Secondly, it excites an immediate defense reaction in the intra-articular tissues with the formation of much fibrin, and at the same time reduces oozing time to a minimum. Further, as the defense reaction wanes, a repair process is stimulated. Apparently the normal body process of defense and repair is speeded up with a resultant early resolution, thereby limiting fibrous adhesions. Thirdly, the fluid influences intra-articular viscosity, and the lubricant factor in joint function is favorably affected. The results obtained by arthrotomy after injection of this fluid in this study compare favorably with those of others as regards postoperative complications,

volume of the concentrate. This procedure was repeated from two to seven times. In an as yet unpublished paper on "Arthritis", a detailed report of these cases will be given. It suffices here to say that the results in the cases where the concentrate was used were satisfactory. The symptoms cleared up, and during the period of hospitalization the improvement was maintained.

In this connection, consideration must be given to the work of Keefer, Holmes, and Myers on the inhibition of tryptic digestion of cartilage by synovial fluid from patients with various forms of arthritis. They state that the antitryptic substances in the synovial fluid stop cartilage destruction. It is possible that the concentrate contains such elements.

The concentrate was used in two cases where the arthritic process had burned itself out and had left crippled, dry joints. After the correction of a flexion deformity, from one to five injections of the concentrate were made. It is believed that by this procedure fairly good joint function was established. This is an extensive field for further study.

Again it seems justifiable to assume that the defense-repair mechanism excited by the amniotic fluid had, as its end result, a resolution of joint pathology without fibrous adhesions.

### SYMPATHETIC JOINT EFFUSION

It is well known that pathology in the vicinity of a joint will at times incite a sympathetic joint effusion, as illustrated by the following case.

CASE 39. The patient, a male, aged forty-four, gave a history of attacks of pain in the lower right thigh. During the last attack his knee had become swollen and painful. Roentgenographic examination showed a small, well-circumscribed Brodie's abscess in the lower end of the right femur close to the joint. The joint was hot, tender, and painful. A moderate effusion existed.

Aspiration was performed and forty-five cubic centimeters of clear, non-coagulable fluid was removed, which showed a total white count of 1800 and 21 per cent. neutrophiles. The fluid was bacteriologically sterile. These findings agree with those of Collins in similar effusions.[2] Sixty cubic centimeters of concentrate was introduced into the joint, and the patient stated that the knee became comfortable almost at once. In sixty hours the joint fluid was negligible, and there was no discomfort in the thigh. Roentgenographic findings did not change. The final result in this case is not known.

### SUBACUTE JOINT INFECTION

There is reason to believe that amniotic concentrate exerts some bactericidal effect. The only literature on the subject [15] is unavailable. However, the following case is of some interest in this connection.

CASE 10. A male, aged forty-seven, developed a swollen and painful left knee without known cause. The temperature varied from 99.8 to 100.8.

The knee was aspirated and sixty-five cubic centimeters of cloudy fluid was withdrawn. This fluid contained many pus cells, and culture showed numerous colonies of staphylococcus aureus. Seventy cubic centimeters of amniotic concentrate was injected. Two days later there was a moderate effusion, and at that time forty cubic centimeters of fairly clear fluid was withdrawn. It contained fewer pus cells with the organisms less numerous. The fluid was replaced with fifty cubic centimeters of the

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time of functional restoration, and final end results. In fractures of the intra-articular type, there is no doubt that the fluid has definite value. In atrophic arthritis it seems indicated where there is effusion or marked synovial-membrane involvement.

It is realized that the number of cases reported is comparatively small, and that no definite conclusions can be drawn with any great degree of certainty. However, the observations made indicate that the use of amniotic-fluid concentrate has some value in orthopaedic disabilities.

SUMMARY

1. In sixty-eight cases in which amniotic-fluid concentrate has been employed in the treatment of various pathological conditions of joints, the use of the fluid concentrate has not been attended by a single unfavorable reaction.

2. Its action is probably both biological and mechanical.

3. It speeds up a defense-repair mechanism within the joints.

4. The results obtained have been impressive in intra-articular fractures, and encouraging in selected cases of atrophic arthritis, as well as in persistent joint effusions.

5. It successfully prevents the formation of new adhesions after closed manipulation of joints.

6. It is a valuable prophylactic after arthrotomy of any type.

7. Its use both in soft tissues and in other serous cavities is suggested.

The advice and splendid cooperation of Dr. C. B. Francisco during the research is much appreciated.

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proximity to the metacarpophalangeal joint, control of the fragment becomes very difficult. (See Figures 3, 5, and 7-A.)

In an individual who, because of his vocation, must firmly grip some tool, such as a hammer, a saw, etc., the displacement causes undue pressure on the head of the metacarpal, with a resultant inability to work efficiently. In the case of a prize fighter, this malalignment prevents him from delivering a blow with full force.

Up to the present time no solution of this problem has been found. The variety of treatments offered is ample proof of this fact.

When any fracture is reduced, the distal fragment is brought into alignment with the proximal one and maintained in that position by some means of immobilization.

In dealing with metacarpal fractures, excluding those in the proximal half of the shaft, there is no direct purchase on the small distal fragment, making it necessary for the surgeon to attempt reduction through the agency of the finger. However, between the proximal phalanx and the fracture site is the metacarpophalangeal joint, which has motion in all directions. This motion must be nullified before direct control of the fragment can be obtained. Extension of the finger does not produce this effect and, to make things worse, it increases the dorsal angulation. As is well known, extension makes the interosseous muscles taut and, since these muscles maintain the angulation, this pull on them will cause greater buckling of the fragments.



FIG. 2-A

Case 1. After reduction and immobilization. Ulnar displacement corrected.

FIG. 2-B

Case 1. Complete correction of the dorsal angulation.

# FRACTURES OF THE METACARPALS

## A New Method of Reduction and Immobilization

BY S. A. JAHSS, M.D., NEW YORK, N. Y.

*From the Hospital for Joint Diseases*

Fractures of the metacarpals, involving the four inner fingers, have always been a disturbing and vexing problem. Irrespective of the fracture site, the deformity is always the same,—namely, *dorsal angulation.* Since these bones are so comparatively superficial, the cosmetic result is rather unpleasant. There is a "bump" on the dorsum of the hand and, what is even more important, there is a disturbance in the alignment of the knuckles, both in the frontal and in the sagittal planes. The head of each metacarpal is quite prominent in the palm of the hand, due to the angulation of the distal fragment. Particularly is this true of fractures just proximal to the head. The small distal fragment dips sharply downward into the palm and, because of its shortness and its close

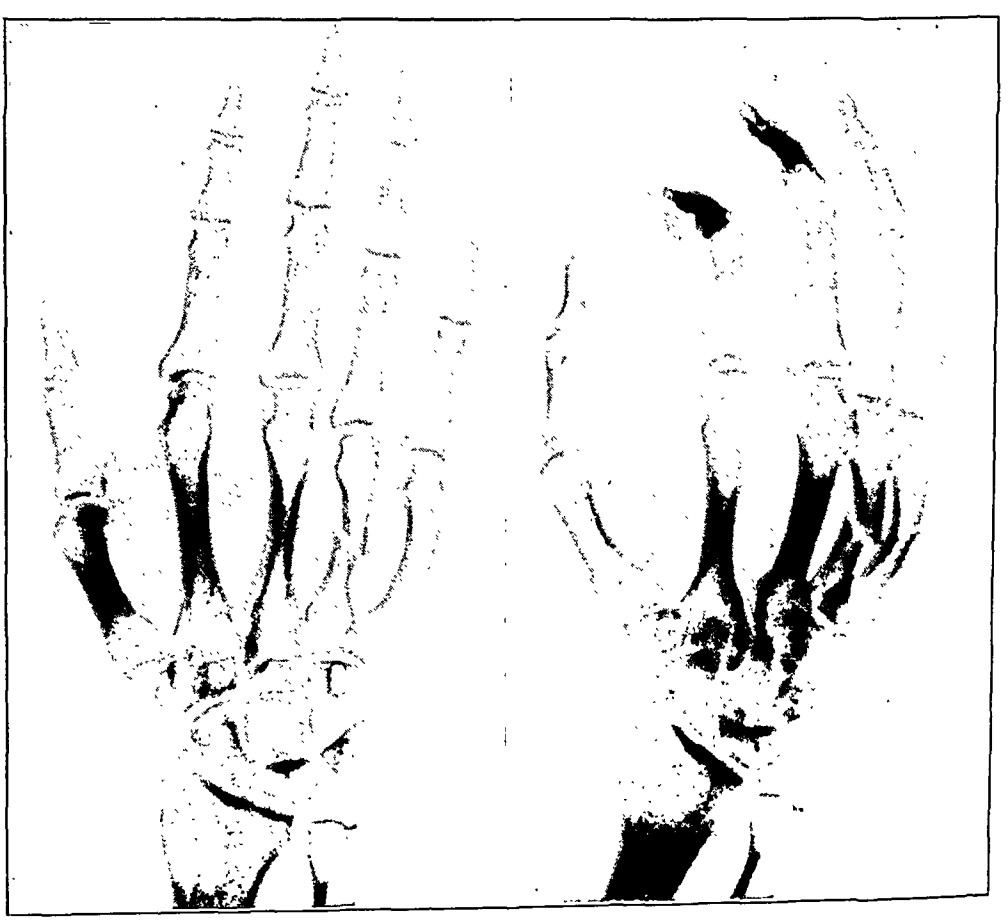


Fig. 1-A

Case 1. Fractures of fourth and fifth metacarpals; ulnar displacement of distal fragment of fourth metacarpal; oblique fracture of fourth metacarpal.

Fig. 1-B

Case 1. Overriding and dorsal angulation of the distal fragment of the fourth metacarpal and some dorsal angulation of the fifth metacarpal.

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# The Journal of Bone and Joint Surgery

## SCOLIOSIS TREATED BY THE WEDGING JACKET

### Selection of the Area To Be Fused

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This article is not intended as a comprehensive study of scoliosis, but as a study of representative cases in which some of the cardinal principles of jacket correction and spine fusion are briefly analyzed, particularly with reference to the selection of the area to be fused. In the five cases described, the following points are illustrated:

1. The minimum fusion area must include every vertebra in the primary curve. There is an occasional exception to this rule in cases where one vertebra at one or the other end of the primary curve may be omitted from the fusion. The primary curvature is that curve in which the deforming factor is active and for which the other curve or combination of curves is compensatory. Occasionally there are two primary curvatures.

2. The ideal fusion area is one which includes at least the minimum fusion area and in which the end vertebrae are parallel to each other and at right angles to the line joining their centers. In the final result the end vertebrae of such a fusion area will be parallel and transverse to the axis of the trunk.

3. The actual determination of the fusion area—whether or not one or more vertebrae beyond the ends of the primary curvature should be included—is made after correction has been obtained by the wedging jacket.

4. Overcorrection of a curvature and fusion in this position is to be avoided.

5. Provided thereby compensation has been restored, remarkable improvement in clinical and roentgenographic appearance often results when the primary curve has been corrected less than 50 per cent.

6. The value of the pelvic-tilt examination as described by Ferguson is emphasized. The patient sits unassisted with the hands resting on the knees; the pelvis is elevated on the side of the convexity of the lumbar curve as much as can be tolerated without causing the patient to lose balance, usually three or four inches; and a roentgenogram is taken.



FIG. 3

Case 3. Fracture of the fifth metacarpal just distal to the head. Note the marked dorsal angulation.



FIG. 4

Case 3. Perfect alignment after reduction.

When the finger is flexed at the metacarpophalangeal joint to an angle of 90 degrees, the head of the metacarpal is so firmly fixed to the base of the proximal phalanx by the collateral ligaments that any motion of that phalanx causes the head of the metacarpal to move along with it. In this position, by pushing upward or dorsally on the flexed finger, extension of the distal fragment is effected, correcting the dorsal angulation, even though the fragments are not handled directly.

In the index and middle fingers this is easily accomplished, but in the ring and little fingers a slight difficulty is encountered,—a little more so in the fifth than in the fourth finger. It is necessary to push these fingers farther dorsally than the others. Upon investigation the reason for this is found to be elementary. In the carpometacarpal joint of the little finger there is extension of about 25 degrees, whereas in the ring finger this motion amounts to only 15 degrees. In the corresponding joints of the index and middle fingers there is no dorsal motion whatsoever. When upward or dorsal pressure is brought to bear on the head of the metacarpal through the flexed finger, the angulation cannot be overcome until the proximal fragment becomes fixed. Since there is no motion in the carpometacarpal joints of the index and middle fingers, the proximal fragment is fixed physiologically, and all the dorsal excursion

FIG. 6-B

Case 7. Perfect alignment of the fragments.



FIG. 6-A

Case 7. After reduction. No dorsal angulation.



FIG. 5

Case 7. Oblique comminuted fracture of the neck of the fifth metacarpal. Dorsal angulation and palmar overriding.

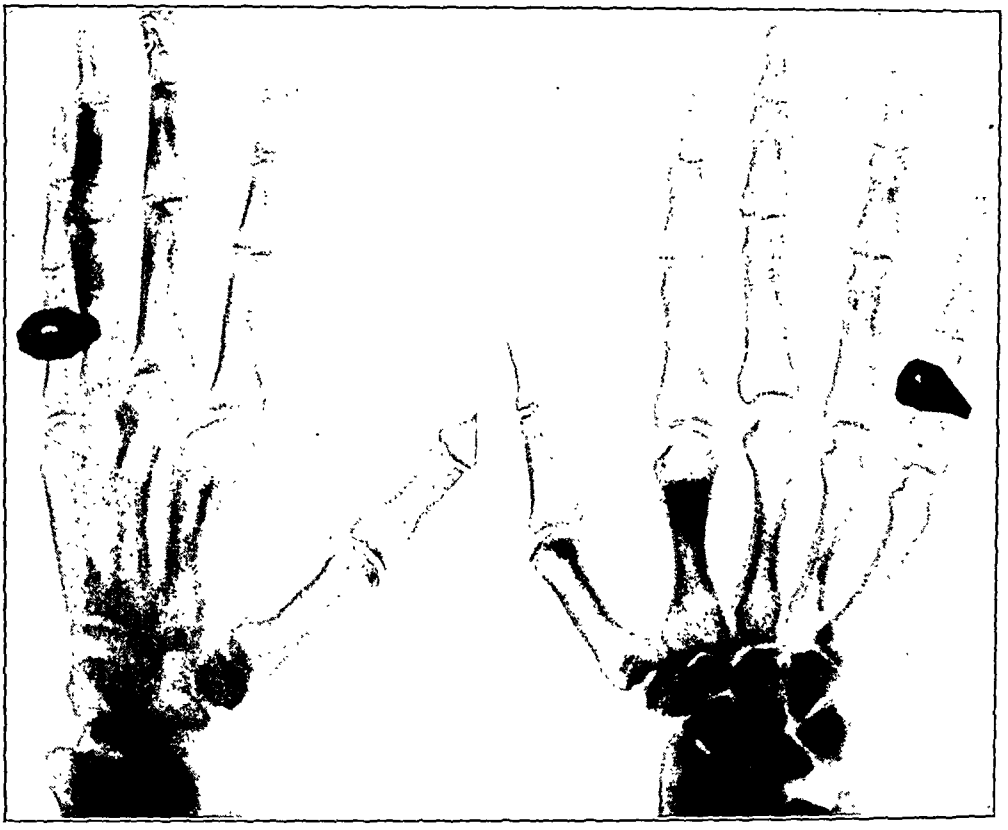


FIG. 7-A

Case 8. Old malunited fracture of the index metacarpal with marked dorsal angulation. Note shortening of the entire metacarpal.

FIG. 7-B

Case 8. Note shortening of the metacarpal. Compare with Fig. 8-B.

that is necessary for the alignment of the distal fragment is the arc of the angulation between the fragments. In the ring and little fingers this excursion is necessarily greater, since not only must the angulation of the fragments be overcome, but, in addition, the arc of extension traversed by the proximal fragment before it becomes fixed at the carpometacarpal joint. However, should the proximal fragment be fixed mechanically, no consideration need be given either to the presence or the absence of motion in this joint. This would make the problem of reduction and immobilization uniform for all fractures of these metacarpals.

### PREREDUCTION REQUISITES

1. *Reduction of either overriding or lateral displacement must first be done.* Traction, countertraction, and manipulation, with the entire finger in *flexion*, usually produce the desired effect.

2. *Should the fracture be an impacted one, it is absolutely imperative that it be broken up. The distal fragment must be freely movable before either correction of the angulation or immobilization is attempted.*

### REDUCTION AND IMMOBILIZATION

Since reduction is so intimately associated with the immobilization, these two procedures will be discussed together.

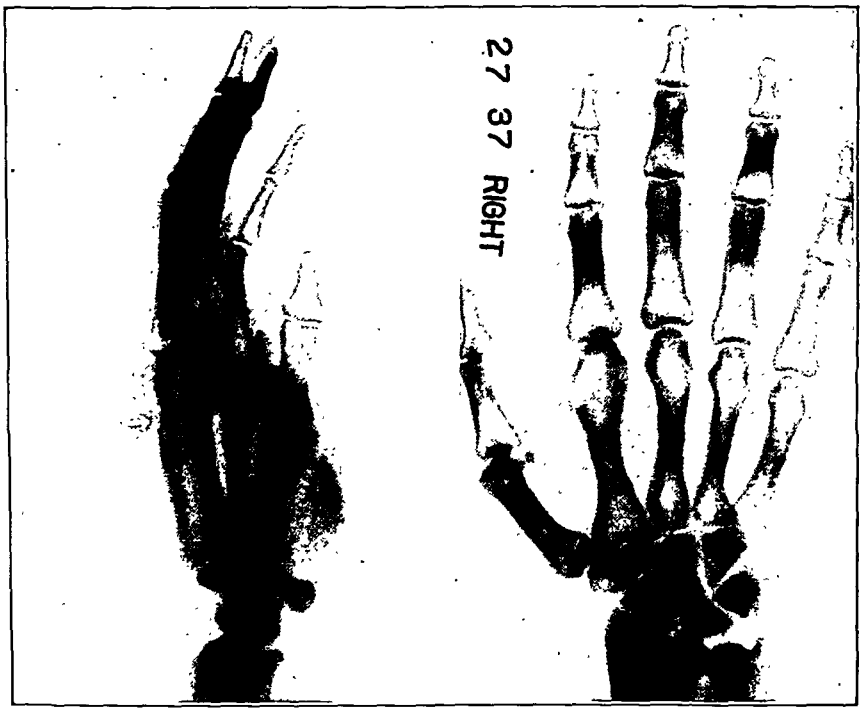



FIG. 8-A

Case 8. Complete correction of the dorsal angulation by the author's method, following preliminary osteotomy.

FIG. 8-B

Case 8. Note the lengthening of the metacarpal. Compare with Fig. 7-B.

Immobilization is done in two stages:

*First Stage*

A strip of heavy piano felt, one inch wide and about ten inches long, is split into two equal thicknesses. After one edge of one strip has been beveled off, the strip is laid across the dorsum of the hand, just proximal to the fracture line, with the unbeveled edge facing the fracture. Since all the counterpressure will take place at this point, it is necessary to pad this part more heavily. The redundant portion of the felt is cut away. One layer of thin, white, tailor's felt is then applied to the hand, from the unbeveled edge of the heavy felt to about three or four inches above the wrist. (See Figure 9-A.) A plaster-of-Paris dressing is next applied to this part of the hand, supplemented with a narrow reenforcement, placed transversely across the dorsum of the hand and overlying the heavy felt. (See Figure 9-B.) This reenforcement assures the maintenance of the counterpressure. The initial plaster dressing fixes the proximal fragment, eliminating the factor of motion at the carpometacarpal joint.

The finger of the involved metacarpal is now flexed at the metacarpophalangeal and proximal interphalangeal joints to an angle of 90 degrees. The distal interphalangeal joint is permitted to remain in extension. With the finger in this position, the second piece of heavy felt is placed over it, from the unbeveled edge of the heavy felt on the dorsum of



FIG. 9-A

Note position of the heavy felt behind the knuckles and just distal to a fracture of the neck of the fifth metacarpal. It is held in position by one layer of tailor's felt, which extends about four inches above the wrist.

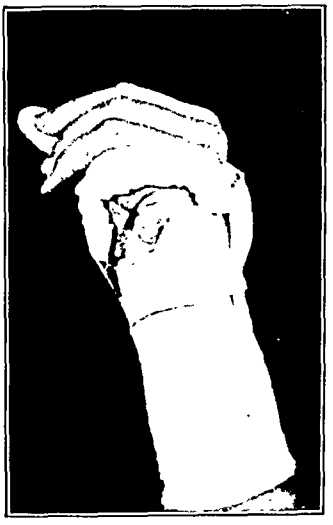


FIG. 9-B

First section of the plaster-of-Paris dressing applied. The second piece of heavy felt has been placed over the flexed finger and strapped to the plaster dressing. The metacarpophalangeal and proximal interphalangeal joints are in 90 degrees of flexion. The distal interphalangeal joint is in full extension.



FIG. 10-A

Note how extension of the distal fragment is obtained through the flexed finger. The palm of the hand is pressing upward on the plaster reenforcement covering the finger from its tip to the flexed proximal interphalangeal joint. Note also that the surgeon's other hand steadies the initial plaster while the upward pressure is taking place. The position of the two hands remains the same until the reenforcement is incorporated in the initial plaster and the entire plaster dressing is set.

the hand to a point just beyond the finger tip. A long adhesive strip holds it in place.

*Second Stage*

One end of a slow-setting plaster-of-Paris reenforcement (one-quarter of an inch thick,

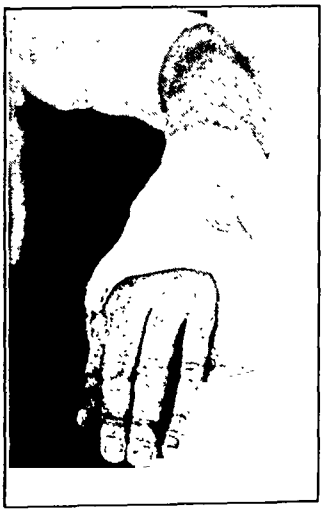


FIG. 10-B

Plaster-of-Paris dressing completed. Dorsal view. "Free knuckles" permit extension of other fingers.



FIG. 11-A

Lateral view. The finger can be inspected easily. The wrist is fixed in about 5 degrees of extension.



FIG. 11-B

Finished plaster dressing. Note freedom of the thumb and the other fingers for flexion.

one inch wide, and about fourteen inches long) is placed on the palmar aspect of the first plaster, four inches proximal to its distal edge, along the extended distal interphalangeal joint to the flexed proximal interphalangeal joint. With the palm of the hand, gentle upward or dorsal pressure is exerted on the reenforcement covering this part of the finger (from its tip to the flexed proximal interphalangeal joint), with most of the force at the flexed proximal interphalangeal joint, until the dorsal angulation is overcome. (See Figure 10-A.) Once this is accomplished, the pressure remains constant to maintain the correction. An assistant then quickly brings the remainder of the reenforcement over the proximal phalanx and the knuckle, and, finally, onto the dorsal aspect of the first plaster for a distance of about three or four inches. The reenforcement is then immediately incorporated in the first plaster with one plaster bandage by including only those parts which overlap the first plaster. (See Figures 10-B, 11-A, and 11-B.) The dorsal or upward pressure is not released until the entire plaster is thoroughly set.

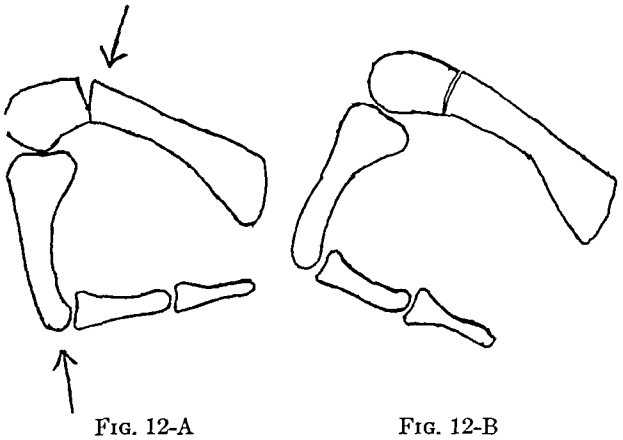


FIG. 12-A FIG. 12-B

Fig. 12-A: Before reduction. Upper arrow shows the downward thrust exerted by the edge of the initial plaster dressing. The lower arrow shows the upward or dorsal thrust by the long plaster reenforcement.

Fig. 12-B: After reduction. Showing correction of the dorsal angulation, the resultant action of the two forces.

At times, due to the motion present in the carpometacarpal joint of the fifth finger, ulnar deviation of the distal fragment takes place. This is easily controlled by extending the transverse dorsal plaster-of-Paris reenforcement over the sides of the index and little fingers, following manual correction by radial pressure.

*A word of caution is necessary.* The second section of the plaster should not be applied unless the distal fragment is freely movable. When such is the case, very little force is necessary to produce perfect alignment. Should this precaution not be taken, then the amount of force necessary to correct the angulation is such that a pressure sore will undoubtedly develop over the proximal interphalangeal joint. The development of an area of local skin necrosis does not, by any means, presage a poor result. It merely prolongs the treatment.

## AFTER-CARE

Immobilization for two and one-half weeks is usually sufficient. Massage, local heat, and exercises are indicated. Most important of these are the active and passive exercises.

There is always some fixed flexion present at the metacarpophalangeal and proximal interphalangeal joints when the plaster is removed. It is much more pronounced in the latter joint. This is due to periarticular adhesions, which must be thoroughly broken up. It is the author's practice to do this at the time when the plaster is removed. When the joints are gently extended by the surgeon at this time, a sudden give will be felt soon after the inception of this passive motion. As soon as this takes place, full extension is rather easily accomplished. Subsequently, complete passive flexion and extension are carried out daily until such time as the patient can actively flex and extend these joints within the normal range. Immediately after the first manipulation, the patient has no power of extension in the proximal interphalangeal joint. The finger hangs limply at this joint and one may become concerned over this absence of function. Within one or two days the power of extension returns. The patient is instructed to move these joints actively and passively many times a day.

Too much stress cannot be placed on the importance of the after-treatment. An excellent result, with no restriction of motion, can be expected, if diligent and painstaking physiotherapy is carried out. Otherwise, some restriction of extension is the rule. This restriction of motion, strange to relate, is usually at the proximal interphalangeal joint and not at the metacarpophalangeal joint. Why it should affect a joint not even close to the fracture, while the joint actually at the fracture site remains free, is a phenomenon for which no explanation is offered.

The present series comprises ten cases. Of these, nine were recent fractures and one was an old malunited fracture. (See Figures 7-A and 7-B.) In this last case, an osteotomy through the angulation was done, and the case was treated as if it were a recent fracture. (See Figures 8-A and 8-B.)

The results in the ten cases have been uniformly good.

## SUMMARY

Fracture of any one of the four inner metacarpals can be reduced by upward or dorsal pressure on the flexed distal fragment, with the metacarpophalangeal and proximal interphalangeal joints of the involved finger held at 90 degrees of flexion. This position at the metacarpophalangeal joint relaxes the interosseous muscles and at the same time tenses the collateral ligaments, permitting extension (correction of the angulation) of the distal fragment through upward or dorsal pressure on the flexed proximal interphalangeal joint. This correction can be best maintained if the plaster-of-Paris dressing is applied in two sections: the first, to immobilize the proximal fragment; and the second, to maintain the correction.

The author wishes to express his thanks to Dr. S. Kleinberg and Dr. H. Lusskin who treated Cases 8 and 7 according to his method.

# ADAMANTINOMA OF TIBIA

## Report of a Case *

BY DONALD J. REHBOCK, M.D., AND C. G. BARBER, M.D.,
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The adamantinoma, an epithelial tumor long recognized as arising in the jaw and in the hypophysis cerebri, is known also to occur in a third location,—namely, the tibia. Fischer first described such a tumor of the tibia in 1913. Not until 1930 was a second case described by Richter, and since then four more cases have been recorded by Baker and Hawksley, Ryrie, Holden and Gray, and Bishop. It is the purpose of this paper to report the clinical and pathological aspects of an additional case.

### CASE REPORT

R. S., a Jewish housewife of twenty-four years, entered St. Vincent Charity Hospital on October 14, 1936, complaining of pain in the left ankle. She had sprained the ankle



Fig. 1-A Fig. 1-B

Roentgenograms of left tibia, showing character of bone involvement.

* Received for publication May 11, 1937.

eighteen months previously and since that time had had slowly progressive difficulty in walking.

Examination showed an obese woman who limped. On the medial aspect of the lower third of the left leg there was a rounded, tender, slightly fluctuant, subcutaneous mass, approximately six centimeters in diameter. This was fixed to the tibia, but not to the skin. The overlying skin was elevated one and five-tenths centimeters above the surrounding skin surface, but was not discolored.

Roentgenograms showed a cavity, four centimeters in length and two and three-

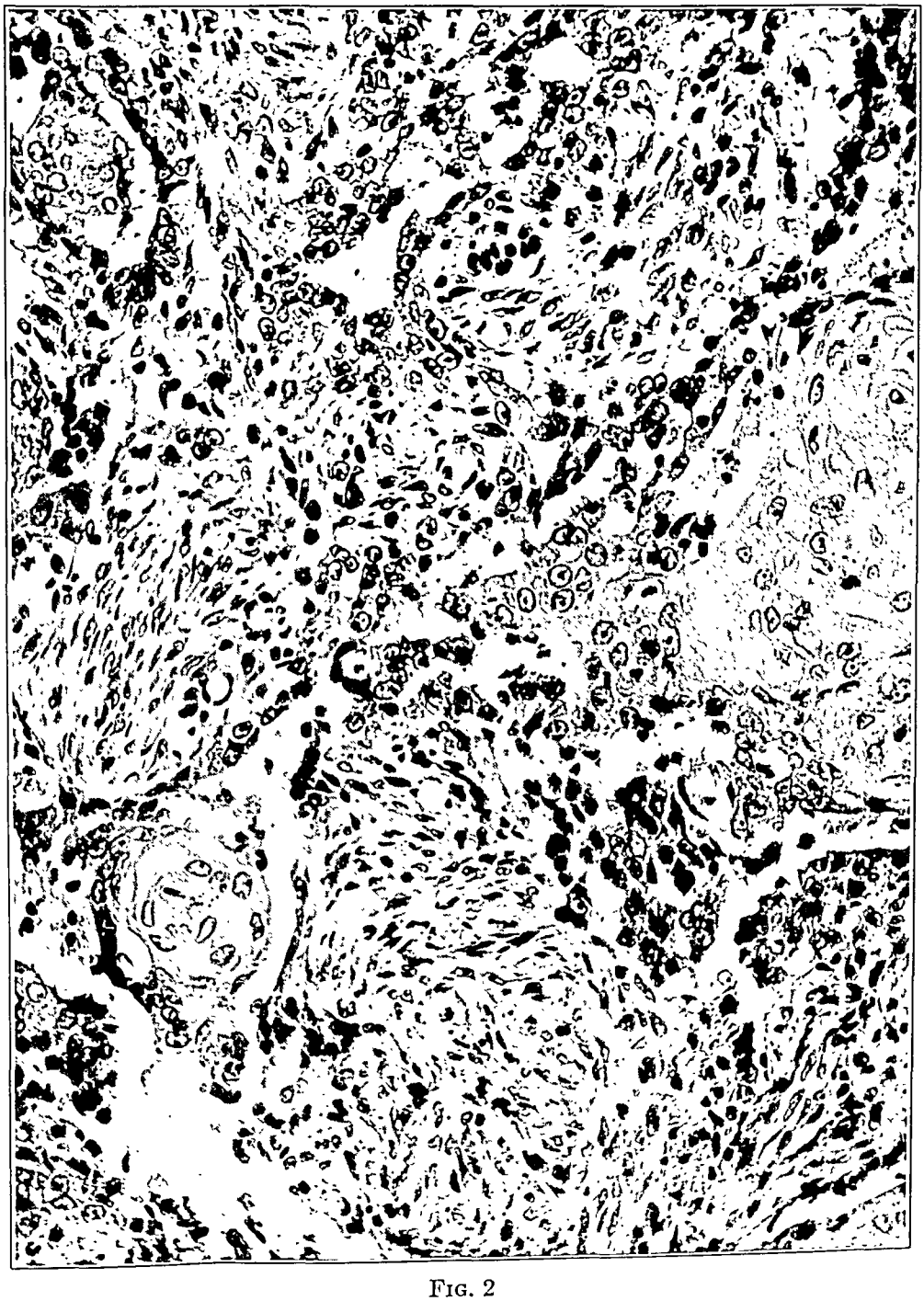


FIG. 2

Photomicrograph (× 200) of tumor, showing areas of cystic degeneration surrounded by rows of cuboidal epithelial cells. Squamous type of epithelium on right.

tenths centimeters in diameter, situated in the lower third of the tibia with its lower margin two and five-tenths centimeters above the articular surface. The borders of the cavity were regular and sharply outlined, and there was no reaction in the surrounding bone. The cavity had broken through the cortex posteriorly. The periosteum was slightly thickened from the internal malleolus upward for eight centimeters over the medial and anterior surfaces of the tibia. The lesion was interpreted roentgenographically as a Brodie's abscess, particularly because of the sharp limitation of the borders of the cavity and the inflammatory type of periosteal thickening.

At operation on October 15, 1936, the presenting portion of the lesion was found to

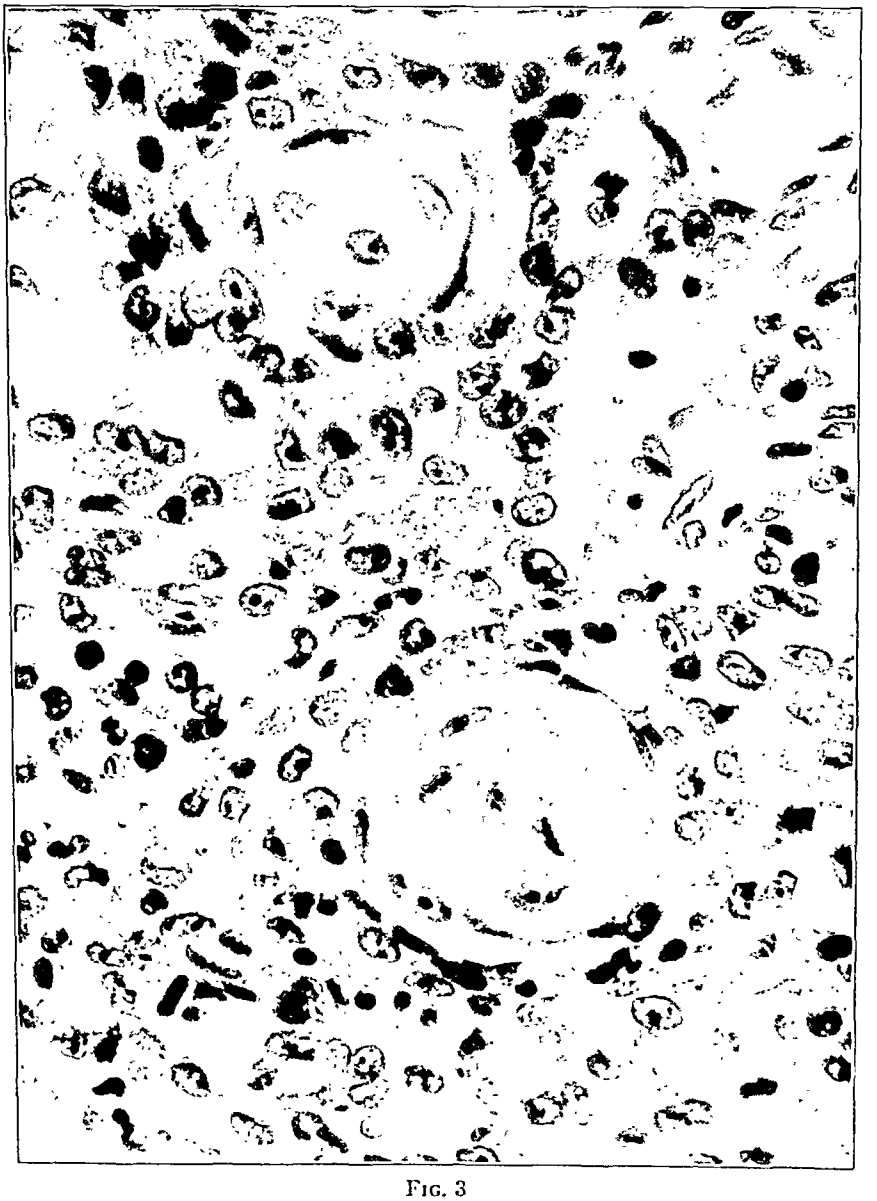


FIG. 3

Photomicrograph (× 480) of tumor, showing epithelial pearls.

TABLE I

ANALYSIS OF REPORTED CASES OF ADAMANTINOMA OF THE TIBIA

| Case | Author and Year Fischer (1913) | Age (*Years*) | Sex | Site | Symptoms | Duration of Symptoms Prior to Operation | Preoperative Diagnosis | Operation | Result |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 37 | Male | Left tibia | Pain and swelling | 5 months | Primary tumor | Tibial resection and bone graft | |
| 2 | Richter (1930) | 12 | Male | Left tibia, middle third | Swelling | 8 months | Myelogenic sarcoma | Amputation | |
| 3 | Baker and Hawksley (1930) | 46 | Male | Left tibia, lower third | Pain | 6 weeks | Myeloma | Subperiosteal resection of 4-inch segment of bone | |
| 4 | Ryrie (1932) | 44 | Male | ? | Pain and tenderness<br>Swelling | 16 years<br>8 years | Bone sarcoma | Tumor curetted out | Recurrence in 6 months. Amputation. |
| 5 | Holden and Gray (1934) | 36 | Female | Left tibia, lower third | Pain | 2 years | Bone cyst | Wide local excision | Recurrence in 2 years. |
| 6 | Bishop (1937) | 22 | Male | Right tibia, upper third | Swelling | 3 years | Bone cyst or giant-cell tumor | Curettage and cauterization | Recurrence in 14 months. Amputation. |
| 7 | Rehbock and Barber (1937) | 24 | Female | Left tibia, lower third | Pain | 18 months | Brodie's abscess | Wide local excision | |

have a thick fibrous capsule which fused with the adjacent tendons and muscle. Incision through the capsule showed one large cavity and several small cavities filled with a thin, clear, straw-colored fluid. The outer wall of the mass contained no bone and it was removed for pathological examination. On October 20, 1936, the involved tissues were widely excised, leaving a narrow bridge of healthy tibial shaft. The wound healed rapidly, and the patient was discharged in eleven days, wearing a cast. Subsequent roentgenograms of the skull showed no evidence of tumor in the jaws or pituitary fossa. On June 19, 1937, eight months after operation, there was no roentgenographic evidence of tumor recurrence in the leg.

*Pathological Examination:* The biopsy specimen on October 15, 1936 consisted of a single piece of firm, pale tissue, measuring three and five-tenths by two and five-tenths centimeters by one centimeter. This was covered over one surface by a fibrous membrane representing the external capsule of the tumor. The tissue was dense, firm, and tough, but contained no cartilage or bone. The specimen removed on October 20, 1936 consisted of sixty grams of fragmented bone and soft tissue.

Microscopic examination showed dense fibrous connective tissue, throughout which were irregularly disposed epithelial masses. In some situations these epithelial masses were characterized by a peripheral single layer of small cuboidal cells, followed within by flat or polygonal cells. More centrally, these masses showed hydropic infiltration with nets of polygonal, stellate, or branching cells. Cystic spaces were present in some areas. There were epithelial pearls with and without keratinization, some showing calcification. In many areas compact epithelial cells without architectural arrangement were disposed without sharp demarcation from the fibrous stroma. The bone adjacent to the soft tissue tumor showed degeneration of bony trabeculae, fibrosis of marrow spaces, and irregular penetration by the tumor for a short distance.

## COMMENT

That a tumor producing the essential features of the enamel organ should occur as a primary tumor in the lower third of the tibia seems bizarre. Malassez's theory as to the origin of the adamantinoma of the jaw is acceptable, as is pointed out by McFarland and Patterson in their thorough review of the subject of adamantinomata. According to this theory, the tumor in the jaw arises from atrophic or isolated groups of epithelial cells about the roots of the teeth. The adamantinoma of the hypophysis originates in epithelial remnants of the hypophyseal duct. The origin of this tumor of the tibia, however, is less clearly explained. Fischer assumed that it originated from a foetal cell rest formed during the intra-uterine period. Baker and Hawksley followed Fischer in postulating a foetal epithelial rest, but laid some stress on trauma as stimulating the rest into growth. Ryrie also emphasized the etiological importance of trauma, but believed that the growth arose from epithelium implanted at the time of injury.

There is no doubt concerning the identity of these tumors with those of the jaw and the hypophysis. As was pointed out by Duffy, adamantinomata of whatever location produce a structure which tends to reproduce the essential features of the enamel organ. The columnar peripheral layer of the neoplastic epithelial processes corresponds with the so-called "inner layer" (of adamantoblasts) of the enamel organ, the subcolumnar transitional zone of vesicular epithelial cells with the "intermediate zone," and the reticulated hydropic central zone of stellate epithelial

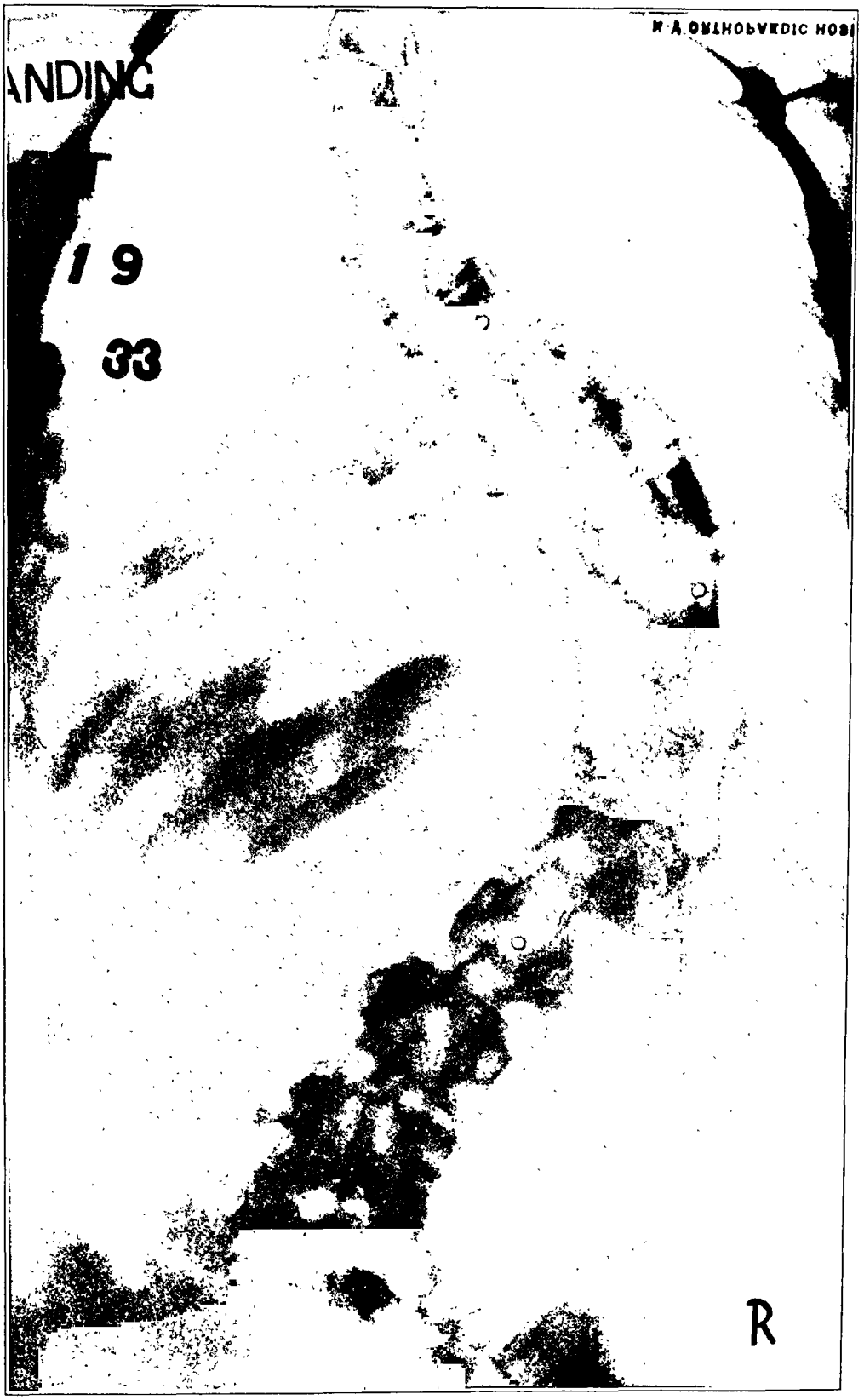



FIG. 1

Case 1. Preoperative roentgenogram, with patient standing.

# TENDON TRANSPOSITION

## An End-Result Study *

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### INTRODUCTION

In presenting this paper, the writer assumes at the outset that it would, to the majority of orthopaedic surgeons, be unnecessary and superfluous to demonstrate the proposition that tendons or muscles can be transposed to a new site and function in a new direction, even though this elementary fact may not have unanimous recognition.

On the other hand, the writer, from his own clinical experience plus observations of this phase of surgery in many different localities over a period of nearly twenty years, is very definitely of the conviction that a wider application and a more satisfactory achievement in the ultimate functional result would obtain through appreciation and acceptance of certain precise and standardizable indications for the utilization of this type of surgery. It is his impression that the modern orthopaedic surgeon with good basic surgical technique and understanding of the principles of tissue physiology and healing, established long ago by Lange, Biesalski, and Mayer, can quite uniformly produce a functioning tendon transplant. That the procedure has been too often disappointing to patient and surgeon in its ultimate benefit and has as a result a minority of enthusiastic adherents is due, the writer believes, to an inadequate recognition and appreciation of the part played by certain physical principles in the selection and indications for the procedure. Its greatest field is, of course, the disabilities residual from anterior poliomyelitis; yet the unequal distribution of this disease restricts the practical experience of surgical rehabilitation to a comparatively few surgeons. At the same time, while much has been written relative to the technique and results of certain specific operative procedures, there is little or nothing of importance on the phase of selection and indications, and particularly on the physical factors involved, in our literature (textual or current) since the early work of Lovett.

The possibility of a somewhat authoritative contribution on this subject arises from a body of clinical material under the writer's control during the last ten years which has provided opportunity for about 300 operations for tendon transposition, 240 of which were performed more than three years ago. Of these 240 patients, 215 were examined for results after such an interval. As to the question of obtaining a working

* Presented before the American Academy of Orthopaedic Surgeons, Cleveland, Ohio, January 12, 1937.

cells with the enamel pulp or middle zone of the enamel organ. The slow rate of growth, cystic degeneration, tendency to recur after local excision, and failure to metastasize are characteristic of these tumors whether in the jaw, the pituitary body, or the tibia.

The diagnosis of adamantinoma of the tibia can be made only by histological examination. However, the characteristic location, the history of trauma followed by a latent period and then by pain, and a roentgenographic picture of a sharply outlined area of bone destruction should lead one to consider the possibility of adamantinoma. Once the diagnosis is established by biopsy, the operation of choice is resection of the shaft of the tibia, followed by a bone graft. In doing the resection one should keep well above and below the tumor area. Local resection of the tumor with the chisel and curette in three of the previously reported cases was found to be inadequate.

Grateful acknowledgment is made to Dr. Francis Carter Wood for the photomicrographs which accompany this case report.

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cation for combining the two types of procedure at one operation if the age is appropriate. The second postulate is that, for essentially static deformity, tendon transposition as a rule will not suffice, and joint fusion will be necessary; but, in contrast to dynamic deformity, static deformity is easily susceptible of mechanical control during the period prior to the applicability of bony stabilization. Thus, procedures of tendon transposition may be undertaken with one of three distinct aims: (1) purely to restore a lost functional capacity, mainly applicable to the upper extremity; (2) to remedy a positive or dynamic imbalance by a balanced redistribution; and (3) to remedy a static imbalance by tendon transfer alone (biceps transposition at the knee).

The second key consideration is the evaluation of the muscle which suggests itself for tendon transposition, both as to its state of efficiency and as to its physiological adaptability. At the outset, it should be stated that the necessity of complete reversal to an opposite function is no contra-indication to selection; re-education may be slower, but, if other principles are observed, an effective reversal of function can be expected. On the other hand, any degree of paresis or weakening is a contra-indication if the primary purpose of the transposition is to replace a wiped-out muscle or group of muscles. A subnormal muscle may still be selected for transfer when it is a factor in dynamic instability if this is the primary consideration, or when its transfer places it in combination with another only slightly subnormal but inadequate muscle or group. Finally, its physiological action must be considered. A short-bellied, short-excursion, steady-pull muscle is not adapted to replace the opposite — that is, the strap-type, long-excursion, light-load muscle—and *vice versa*. It should, of course, go without saying that accurate testing and rating of all muscle groups of the affected part are essential for any proper evaluation of the presenting situation and the possibilities for its relief. In the analysis of the clinical material which has led to the establishment of specific indications, a grouping into five basically different types of imbalance has been done.



FIG. 1–A



FIG. 1-B

Fig. 1-A: Typical early diagnostic complex of isolated weakness of tibialis anterior. On dorsal-extension effort, the foot goes into the clawed position and remains in plantar flexion; on weight-bearing, the foot is in planovalgus.

Fig. 1-B: Balanced control after proximal transposition of extensor hallucis longus.

or functioning muscle after transposition, some postoperative observations prevail on the entire 300, with positive findings in 92 per cent. Of the 215 patients checked up at periods of from three to ten years after operation, a strongly working transplant was observed in 90 per cent. Of the total cases, a considerable number represented a variety of types of paralytic residuals, of which no one group was sufficiently large to warrant dogmatic conclusions; but there remained several different situations in which the experience seemed adequate to make quite positive predictions as to indications and results.

## DISCUSSION

Inasmuch as in this study sufficiently extensive evidence from the statistical angle is limited to work on the lower extremities, discussion will be restricted to this phase. However, it is here that what the author regards as the key considerations are most particularly involved. The foremost of these is the necessity of determining to what degree the disability or deformity is static (negative) and to what degree it is dynamic (positive). The most obvious example of dynamic deformity is the calcaneus foot; of static deformity, that planovalgus foot which, more or less flail, is without any power in the invertors. In the former instance, no amount or extent of arthrodesis alone will prevent in the growing child a recurrence of deformity. In the latter instance, fusion and block procedures readily eliminate all further concern about deformity.

Other situations are not so simple, and we must realize that dynamic instability is always present to some degree whenever the antagonists of any weakened muscle group are strongly active. For instance, when the invertors of a foot are inadequate to static stress, the planovalgus deformity will include a static element, but, if the peroneal group is strongly active, a dynamic element is added, which, if overlooked, will spoil the result of any arthrodesis. While the drop-foot equinus element of the flail foot is a negative or static one, it is not difficult to control by corset shoe, brace, tenosuspension, or bone block. On the other hand, the equinus element of a foot with impaired dorsiflexors and strong plantar flexors tends to overcome any measures of control as long as the dynamic imbalance of unopposed calf-muscle groups remains.

Accordingly, we can establish two primary postulates. The first is that essentially dynamic imbalance is an imperative indication for "redistribution", a reconstructive procedure, with experience showing that transposition can be so adapted as to restore both balance and adequate function, often without necessity for sacrifice of normal mobility. The indication has no limitation to any age period, for, even if entirely complete stability may not in certain situations obtain from redistribution alone, deformity becomes easily preventable by minimal support until an appropriate age for some limited joint fusion is reached. When an imperative indication for redistribution by tendon transposition is also accompanied by additional need for joint fusion, there is no contra-indi-

flexion were satisfactory in all. In the other type, when the planovalgus was moderate and easily correctable, this tendon transposition alone gave a high percentage of satisfactory results, both as to statics and to extensor function. In the presence of severely relaxed or fixed planovalgus, an astragalonavicular arthrodesis was combined with the tendon transposition.

The whole series of forty-three cases were analyzed from the standpoint of (1) extensor function and (2) posture. In regard to the former, adequate function prevailed in thirty-four, was improved in eight, and was unchanged in one. Restudy of the last case indicated an original rating of some impairment of the extensor hallucis longus which, in the absence of an active tibialis anterior, should have ruled this case out of this group. In all instances but one, those cases in which function was improved but not adequate had presented with a recurrent equinus after lengthening of the Achilles tendon done elsewhere. In this whole group, contracture of the Achilles tendon was overcome before operation when possible by gradual stretching, and the only cases in which it was not possible and in which tenotomy was required were those of prior lengthening of the Achilles tendon. In respect to posture, twenty-nine patients had good posture; nine, fair; and five, poor (pronation). Analysis of these last five cases revealed two in which an overlooked impairment

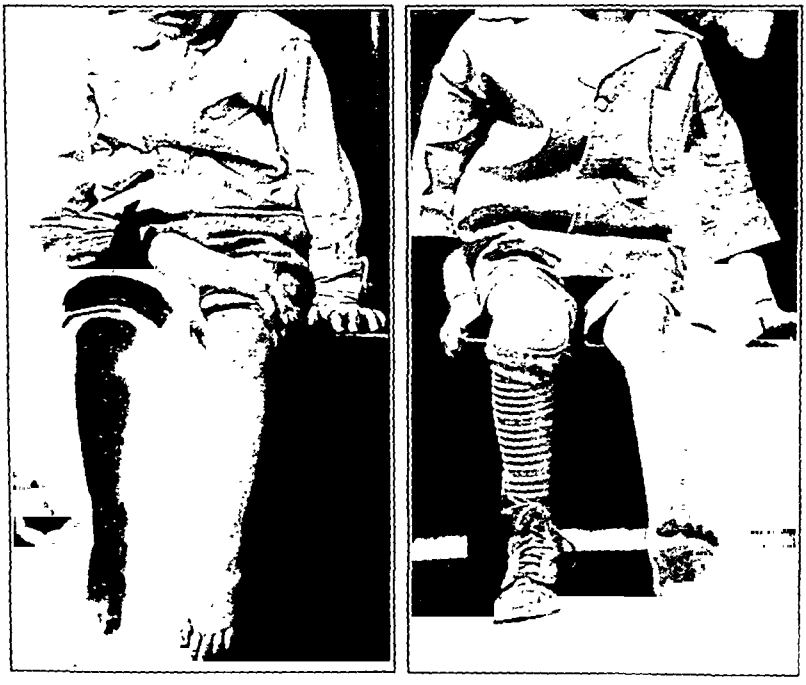


FIG. 3-A FIG. 3-B

Complete loss of dorsal extensors with weakness of invertors.
Fig. 3-A: Function before operation.
Fig. 3-B: Function after forward transfer of both peronei. No arthrodesis was done. Note neutral posture of foot.

GROUP I—LIMITED EXTENSOR-INVERTOR INSUFFICIENCY

Forty-three cases are available in which a specific transposition was done for this precise type of residual imbalance, consisting of isolated paralysis or notable weakness of the tibialis anterior muscle. The functional defect here is often not apparent early, and deformity is often slowly progressive. The reliable diagnostic complex is a foot in which the effort at dorsiflexion is found to be inadequate with the toes retracting and the foot going into cavus as the effort is made, and in which either permanent equinus or limitation of passive dorsiflexion prevails (idiopathic claw-foot being ruled out by the finding of absent or weak effort in the tibialis anterior). As a rule, on weight-bearing these feet take a planovalgus position, but this group includes some cases which showed no pronation but did have contracture of plantar fascia and moderate cavus. From the angle of muscle-testing, the author has found no explanation of these two different types. Compensation or substitution for the tibialis-anterior inadequacy of course takes place by excessive effort with the common digital extensor and with the proper extensor of the big toe. The writer's impression is that the individual who strives as long as possible to improve this substitution by fixing the toes with their flexor mechanism develops a straight equinus with cavus; in the others the foot assumes the position of planovalgus. In both positions there prevail elements of both static and dynamic imbalance.

In all forty-three cases, restoration was attempted by transposition of the tendon of the strong extensor hallucis longus from its relatively ineffective insertion in the toe to one in the foot itself, usually at the base of the first metatarsal. Save for plantar fasciotomy, nothing else was included in the operation in the cavus type, and both posture and dorsi-



FIG. 2-A FIG. 2-B FIG. 2-C

Complete loss of both tibials, and marked toe-extensor weakness.
Fig. 2-A: Extreme dynamic planovalgus, associated with drop-foot.
Figs. 2-B and 2-C: After operation for forward transposition of both peronei plus Hoke reconstruction of skeletal deformity.

ment; however, in about half of these cases this procedure was necessary. Poor statics resulted after operation in only one of the twenty cases.

Type-B cases were those showing severe impairment of both tibials, as well as of the toe extensors, and transposition of both peronei to the dorsum of the foot was done in thirty-four cases. Adequate extensor function prevailed in thirty-two. Study of the two failures showed that in one case transposition of a peroneal group definitely rated as weak had been done, and in the other infection had occurred. As would be expected, preoperative structural deformity was severe in the long-standing cases, necessitating the Hoke procedure at the time of transposition in twenty-three cases, all of which on check-up showed satisfactory statics. In eleven cases, the transposition was done at an age prior to the applicability of arthrodesis, but on check-up none of these showed inadequate lateral stability, with posture or statics excellent in eight. The writer believes that, if in these early cases the patients continue to wear ankle-high shoes until maturity, arthrodesis for lateral instability will not be necessary.

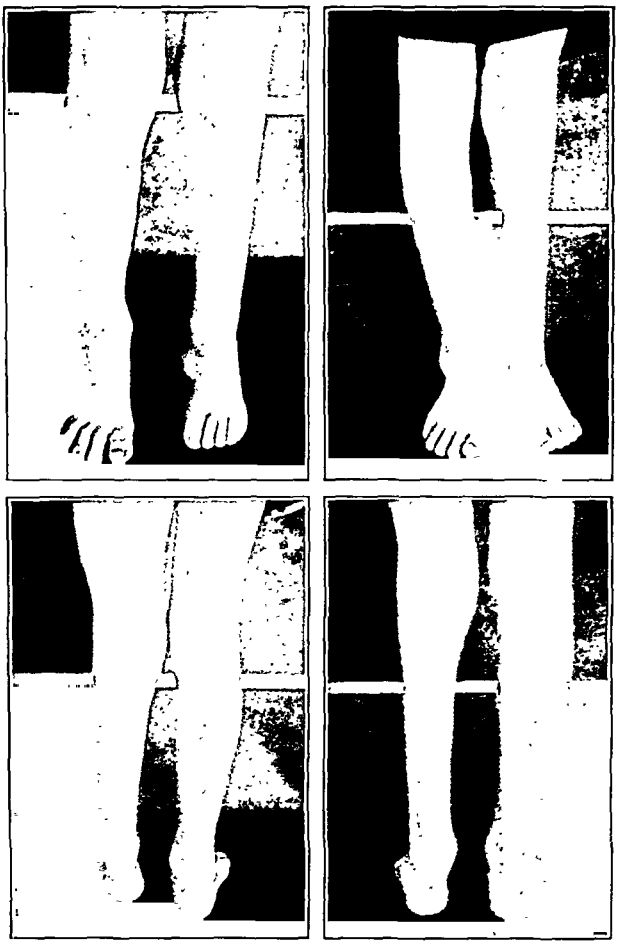


FIG. 5

Anterior and posterior views before and after outward transposition of tibialis anterior tendon for varus instability due to peroneal insufficiency.

In summary of Group II (one or both peronei forward), adequate functional control prevailed in fifty-one out of a total of fifty-four cases, with satisfactory statics in fifty-three; some type of fusion procedure was added in thirty-four. Group II must be considered as being composed mainly of cases of dynamic imbalance, the presenting pattern being equinovalgus from residual extensor-invertor paralysis.

of the tibialis posterior prevailed, and three in which a fusion failed to consolidate, having been done at too early an age.

Accordingly, we have a partly dynamic and partly static situation, in which subtraction from the dynamic side is not necessary, and in which balance and stability can be restored either by transposition alone of the extensor hallucis longus or by a combination of this procedure with astragalonavicular arthrodesis according to the prevailing conditions, the presenting pattern being an extensor-invertor insufficiency from residuals limited to the tibialis anterior muscle.

### GROUP II—GROSS EXTENSOR-INVERTOR INSUFFICIENCY

There were fifty-four cases which fell into this classification by reason of their having notable impairment of the toe extensor musculature in addition to impairment of the tibials. The appropriate indications for tendon transposition required further subdivision into two types, A and B.



FIG. 4-A



FIG. 4-B

Fig. 4-A: Complete drop-foot and beginning cavus resultant from extensive dorsiflexor insufficiency (incomplete for toe extensors).

Fig. 4-B: Active dorsiflexor capacity in stable foot five years after forward transposition of peroneus longus. No arthrodesis was done.

Type-A cases showed extensor inadequacy of drop-foot equinovalgus character, due to weakness or paralysis both of the toe extensors and of the tibialis anterior, but without more than one-grade weakness of the tibialis posterior, the rest of the musculature being normal. In this type of imbalance, if redistribution is done relatively early, there is required nothing more than transposition of the peroneus longus to the dorsum of the foot. Quite a long time ago the author discontinued the technique of transposition completely across into the sheath and the insertion of the tibialis anterior, because, although very adequate dorsiflexion uniformly followed, it sometimes reversed the invertor-evertor imbalance and left the foot unstable in varus, a condition which was found to be obviated by locating the insertion of the transplant at the dorsal aspect of the mesial cuneiform. Transposition was done in twenty cases, in nineteen of which adequate restoration of extensor control resulted. Arthrodesis, usually astragalonavicular, was done only in those cases in which prior to operation deformity had continued until structural changes prevented satisfactory realign-

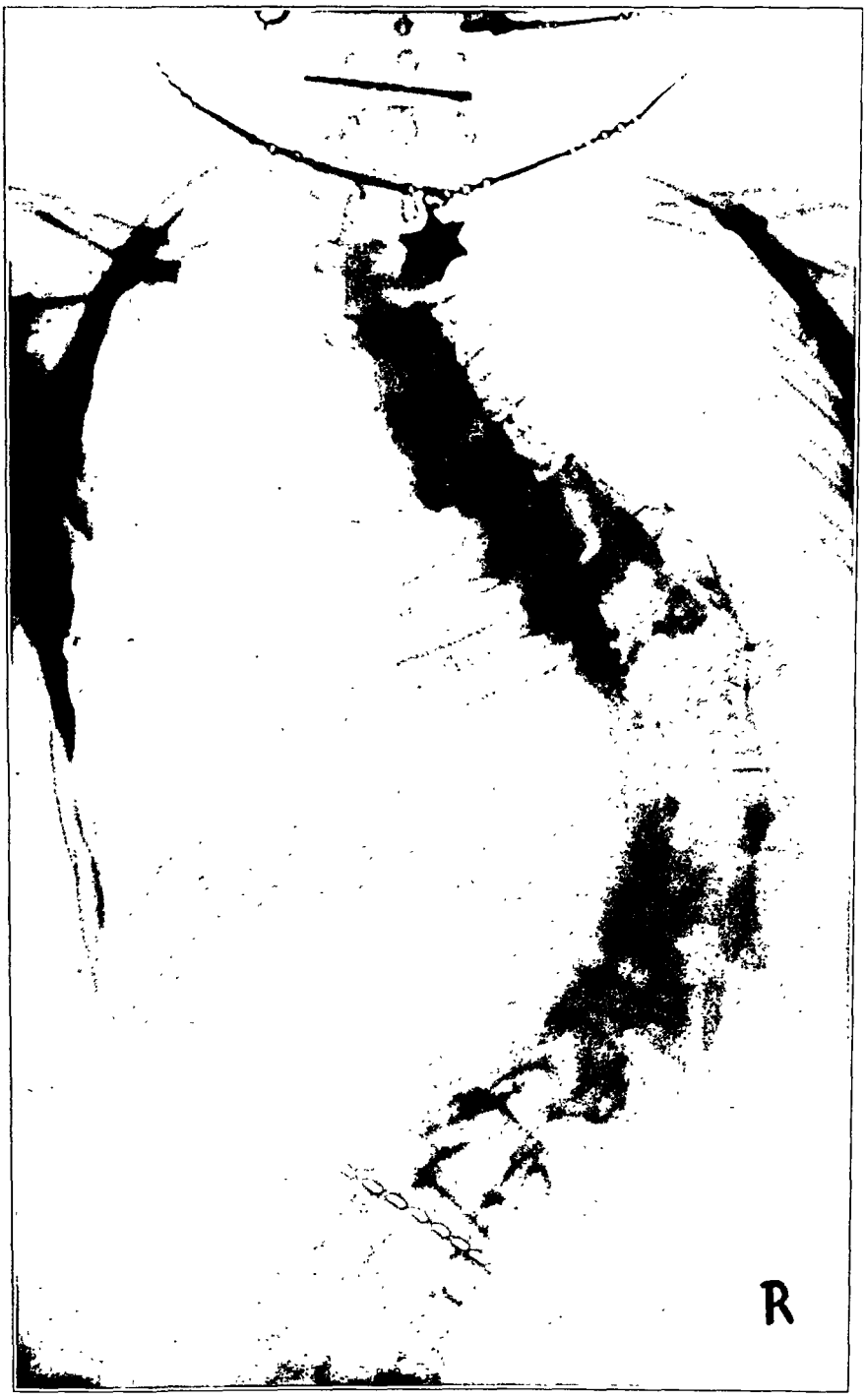



FIG. 2

Case 1. Pelvic-tilt examination. Patient sitting with left side of pelvis elevated.

GROUP III—EVERTOR INSUFFICIENCY

Compared with the other groups, this was a small one, there being only eleven cases. In the earlier years covered by this study, bony stabilization alone was applied to this type of imbalance—namely, loss of power of the peronei, with musculature otherwise normal—but recurrent varus deformities brought the realization that redistribution should be attempted in this pattern also. The operative procedure in the eleven cases consisted of lateral transposition of either the extensor hallucis longus or the tibialis anterior. If the situation showed a slight peroneal impairment, or moderate impairment plus slight weakness of the tibialis posterior, the extensor hallucis longus was transposed to the base of the fifth metatarsal. In instances of greater impairment, the tibialis anterior was transposed to the cuboid and the extensor hallucis longus to the first metatarsal. Balanced extensor function prevailed in all cases; stability and posture were good in seven, fair in three, and poor in one. This particular group was made up entirely of fairly young children and no bony stabilization was added. When a complete loss of power of the peronei prevails, and a normal tibialis posterior persists, greater security against varus imbalance can be obtained by adding tenotomy of this tibial. Long-standing varus instability with advanced deformity will always require the addition of the Hoke procedure, but instability at the ankle joint will eventually develop if this method alone is relied upon. The condition must be regarded as a purely dynamic instability.

GROUP IV—TRICEPS SURAE (TENDO ACHILLIS) INSUFFICIENCY

The author suspects that all orthopaedic surgeons will regard the dynamic calcaneus foot as the most grievous of all types of muscle imbalance, both in the disturbance of gait, the deforming tendencies, and the difficulty of control; and that they also will agree that a foot free from deformity with a pan-arthrodesis in slight equinus position is vastly preferable to calcaneus instability. However, if this imbalance occurs in a small child before the age when such a type of arthrodesis is feasible, the writer does not believe that any appliance will prevent the development of severe deformity. When this deformity is corrected by the necessary bone resections, a badly maimed foot results. The author has seen too many recurrent calcaneus or calcaneocavus deformities after bony procedures done before maturity to have much faith that any such procedure alone can be permanently successful in the face of persistent dynamic imbalance. As far as the age of applicability is concerned, the same argument prevails for control by Achilles tenodesis.

On the other hand, the writer is convinced that appropriate redistribution at an early post-paralytic stage (two to three years) will prevent progressive deformity, but at this point he wishes to state that the only redistribution which he has found to restore completely a heel-and-toe gait and tiptoe capacity is the transposition of the tibialis anterior through the Achilles tendon to the os calcis. However, his experience with this

procedure has been limited to eight cases, only half of which have passed the three-year period. Although so far it has proved satisfactory in restoration of tiptoe function, a more perfect balance might be secured by the additional transposition of the extensor hallucis longus, when this muscle is competent, to the dorsum of the foot.

The observations on this imbalance seem to indicate that a pure calcaneus deformity will result in a condition in which all muscle action is practically absent except that of the dorsal extensors. Isolated paralysis of the triceps surae muscle is regularly followed by a calcaneocavus deformity, a more dangerous one than a pure calcaneus deformity. Insufficiency of the Achilles group, combined with lateral imbalance, adds an element either of varus or of valgus instability.

Leaving aside the eight transpositions already mentioned, there were found available for analysis forty-five transposition operations for some type of calcaneus imbalance, which were subdivided into three groups. Inasmuch as in few cases were the patients able to walk on tiptoe after the procedure, the degree of restored balance was rated as follows: "adequate" when a semblance of heel-and-toe action prevailed and the plantar flexor power was as good or greater than that of the dorsal extensors; "improved" when these conditions were not obtained, but enough power was restored to prevent recurrence of the calcaneus; "failure" when the calcaneus imbalance recurred. The operation did not include any bone surgery in about one-third of the cases.

Type A included twenty-six cases in which the invertors also were impaired, with a calcaneovalgus imbalance from the normal peronei, the

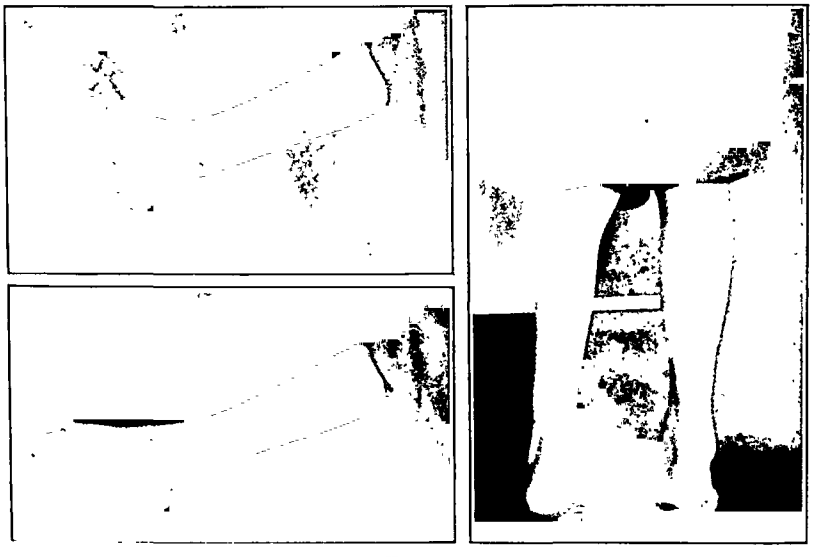


FIG. 6

After transposition of peronei to heel for calcaneus imbalance and weak invertors, showing result in active dorsiflexion, active plantar flexion, and tiptoe position. No stabilization was done.

latter being transposed to the os calcis. Results from the standpoint of function were: adequate, sixteen cases; improved, ten cases. The rating of statics and stability was as follows: of nineteen patients with tarsal fusion, the results were good in sixteen and fair in three; of seven without fusion (operation at an early age), the results were good in four and fair in three.

Type B represented eight cases with a combined varus imbalance from weak peronei, and transposition of the tibialis posterior, as well as of the flexor hallucis longus, was done. Results in respect to function were: adequate in five; improved in two; and failure in one. Posture and stability were good in all cases, but in all either tarsal arthrodesis was done to correct deformity or backward displacement of the tarsus was done to obtain greater leverage.

Type C, usually calcaneocavus deformity, numbered eleven cases. Since the secondary element of deformity was due to the presence both of strong invertors and evertors, the peronei and the tibialis posterior were

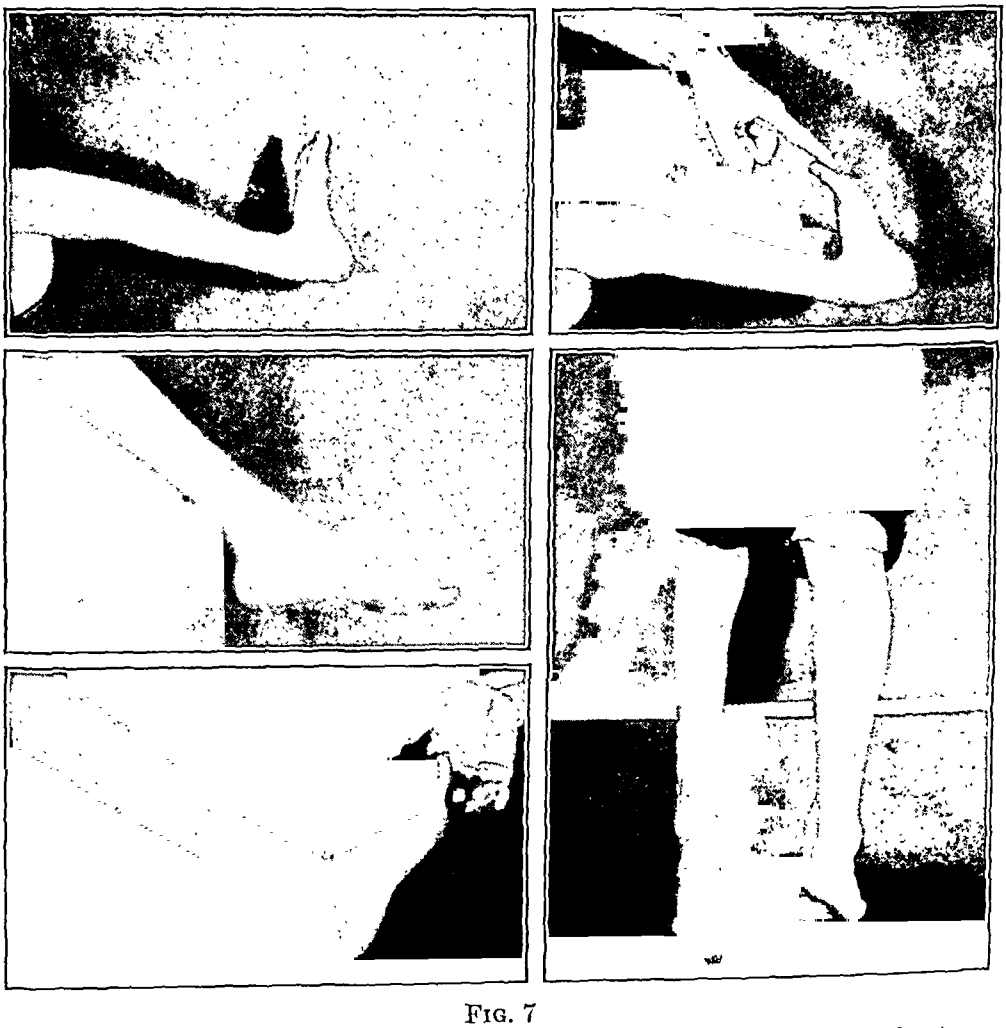


FIG. 7

Calcaneus imbalance from complete loss of all leg muscles except the dorsal extensors; active and passive range before operation; active and passive range and tiptoe capacity several years after transposition to heel of tibialis anterior tendon. No arthrodesis was done.

transposed to the os calcis. Function was rated as adequate in seven cases and improved in four. Although in one of the former there was the nearest approach to tiptoe capacity of all, especial analysis seemed indicated from the fact that the functional capacity of this group of eleven, with double transfers, proved no better in rating than either of the two single-transfer groups. Study of this group brought out the fact that in the greater proportion of the cases advanced skeletal deformity was present, and, in spite of bony reconstructions, normal leverage was on the whole more difficult to obtain; thus, the increased power given by the double redistribution was offset. Skeletal reconstruction was necessary in eight cases with resultant good statics and stability in all. Bone surgery was omitted in three early cases; lateral stability and posture were found to be good in two and fair in one. Going back to the group of eight cases with apparently ideal results from posterior transposition of the tibialis anterior, it should be noted that in that series skeletal distortion had not developed, and no bone surgery was done.

Of the total forty-five cases of calcaneus imbalance in which transpositions of lateral muscles were done, adequate function was obtained in twenty-eight; improved function, in sixteen; and failure, in one. In consequence of these results, the author's present recommendations in calcaneus insufficiency are as follows: (1) In early cases without skeletal distortion, presenting weakness in the Achilles group only, do posterior transposition of the tibialis anterior without any bone surgery; (2) in early cases with complicating lateral imbalance, transpose the acting invertors or evertors, as the case may be; (3) in late cases with skeletal distortion but with muscle status as in (2), add necessary tarsal-joint resections; (4) in late cases with muscle status as in (1), combine tarsal reconstruction with posterior transposition of the peroneus longus and the tibi-

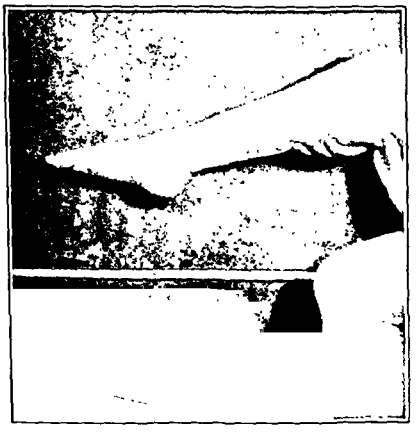


FIG. 8-A



FIG. 8-B

Fig. 8-A: Quadriceps paralysis, showing inability to extend knee against gravity.
Fig. 8-B: Capacity against resistance several years after transposition of biceps to patella.

alis posterior. This is quite feasible as a single operation, but the combination of tarsal reconstruction and posterior transposition of the tibialis anterior is more than should be attempted at one operation. Furthermore, while the tibialis anterior is the only strong leg muscle with a long-range action comparable to that of the triceps surae, extensive tarsal reconstruction is, the writer believes, certain to leave too much restriction of motion to permit tiptoe action even with muscle power adequate for it.

### GROUP V—QUADRICEPS INSUFFICIENCY

There were found in this review eighteen cases of quadriceps insufficiency with hamstrings available for transposition. Except in cases of fixed knee-flexion deformity, quadriceps insufficiency is an example of straight static instability, and an exception to the general rule that this instability is not eradicable by tendon transposition alone. However, if transposition is done before adolescence, protection by brace against genu recurvatum may be necessary, according to hamstring status. In most of the cases of this series, simple forward transfer of the biceps was performed, but in a few with slightly subnormal biceps both inner and outer hamstrings were used. Of the eighteen cases, restoration of approximately normal control was secured in eleven and control adequate for stability in six; failure resulted in one.

### MISCELLANEOUS TRANSPOSITIONS

Of the residual operations in the total reviewed, quite a few were in the upper extremity with transpositions at elbow and wrist, giving very satisfactory results, although not involving the special principles which this presentation was designed to emphasize. There remain a few cases of involvement of the lower extremity which may be mentioned briefly. Six patients received Legg's operation of transposition of the tensor fasciae femoris for gluteus-medius paralysis, with results inadequate to recommend the procedure particularly, and, to the author, illustrating the general rule of inapplicability of transposition of a dissimilar muscle in pure static imbalance. Yet, when this same muscle was utilized in the prime example of exception to this rule—that is, transposition of the tensor fasciae femoris to the patella for quadriceps insufficiency—in three out of six cases a functionally stable knee resulted. The three failures occurred where quadriceps paralysis was complete, while in the successful cases some quadriceps function (though inadequate) had remained. Still under observation are four other cases representing mainly static imbalance,—namely, isolated paralysis of the tibialis posterior, in which by the operative technique of von Baeyer the peroneus longus was transposed across the back of the ankle to the inner side of the foot. The result to date has been complete restoration of both function and statics, so that it may be a useful procedure for this probably rare residual imbalance.

## SUMMARY AND CONCLUSIONS

About ten years ago, the writer arrived at a stage in the practice of surgical relief of paralytic residual imbalance in which the application of certain physical and kinetic principles seemed logically to point to fairly precise indications for selection and utilization of muscle and tendon transference in a given presenting situation of paralytic residuals. Since then, 300 operations have been performed with these principles in mind, and it has been possible to check up on the results three or more years after operation in 215 of these cases. The results have been analyzed according to function and statics, with conclusions and indications derived from the findings in five of the most common and sharply defined situations. Tendon transposition has proved to be a most useful procedure in restoration of lost function, and frequently an imperative procedure in the prevention and control of imbalance deformity. Its utilization diminishes the frequency and the extent of stiffening procedures, sometimes as an adjunct to them and sometimes as a preferable substitute for them. Its success is as much dependent on the meticulous evaluation of the presenting static, dynamic, and kinetic conditions as on the technique of the operative procedure.

# SKELETAL TRACTION IN FRACTURES OF THE RADIUS AND THE ULNA

BY EUGENE L. JEWETT, M.D., ORLANDO, FLORIDA

The method of obtaining skeletal traction which the writer wishes to present is not new, but a few of its features have not been described before as far as he has been able to determine.

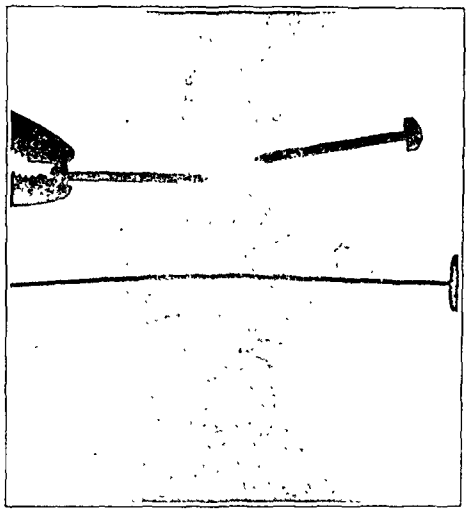


FIG. 1

Showing oblique displaced fracture of lower ends of left radius and ulna with Kirschner wire through the distal fragments and traction screws in the distal ends of the upper fragments. The Kirschner wire through the olecranon process is not shown.

A fifteen-year-old boy sustained a fracture of both bones of the left forearm a little above the wrist joint. His doctor made two unsuccessful attempts at closed reduction. The writer then tried reduction by the closed method. Felt pads were placed in the anterior and posterior interosseous spaces to separate the fragments, and molded plaster-of-Paris splints were carried from the fingers to the shoulder with the elbow at a right angle. Even though the fragments were in good position after reduction, they slipped by each other in a few days. Open operation was advised, but the family were very much opposed to it. Therefore, the following method was evolved, which proved to be highly successful.

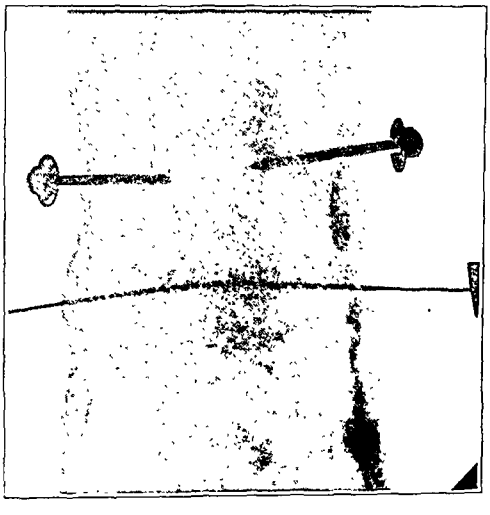


FIG. 2

Fragments in the adequately reduced position with the plaster-of-Paris cast applied and tongue-depressor strips holding the screw heads from the hardened plaster cast.

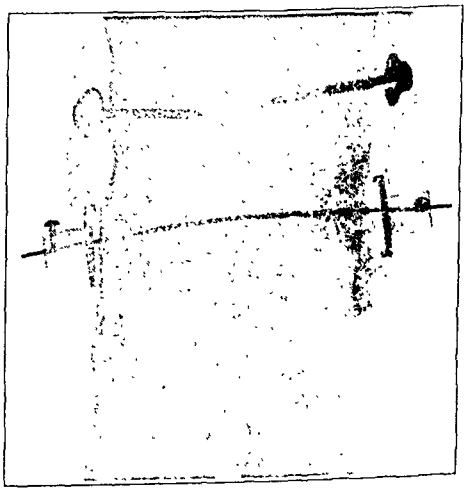


FIG. 3

Outer layer of plaster cast covering the screw heads and the Kirschner-wire retainers, thereby firmly anchoring all of the fragments in the plaster cast by means of skeletal fixation.

Under general anaesthesia, Kirschner wires were placed through the olecranon process and the lower radial and ulnar fragments. (See Figure 1.) The arm was suspended in a fracture frame. Then drill holes were made in the lower end of the upper fragments, as shown in the roentgenogram. Screws, made especially for this purpose, were inserted into the drill holes. Care was taken not to split the bone, but yet to obtain a sufficiently firm hold to give the desired traction. Then, by separating the two Kirschner wires, the desired extension was secured. When the fragments came into line, strong outward traction was applied on the two screws, which resulted in the reposition of the fragments into normal alignment. Repeated roentgenograms indicated when the reduction was satisfactory. A non-padded plaster-of-Paris cast was then applied from the fingers to the mid-arm, incorporating the wires and the screws. Pieces of tongue depressor were snugly placed between the hardened cast and the washers and heads of the screws, so as to prevent any recurrence of the displacement. (See Figure 2.) Plaster was then applied to cover the ends of the screws and the Kirschner-wire retainers (Fig. 3). The wires, of course, were not taken out of the fracture frame until the retainers were securely locked in the hardened plaster. Check-up roentgenograms showed good position of the fragments, and there was free motion of the fingers.

This plaster cast was cut down to the elbow at the end of eight weeks,



FIG. 4

Four and one-half months after reduction. Clinically and roentgenographically the results are excellent.

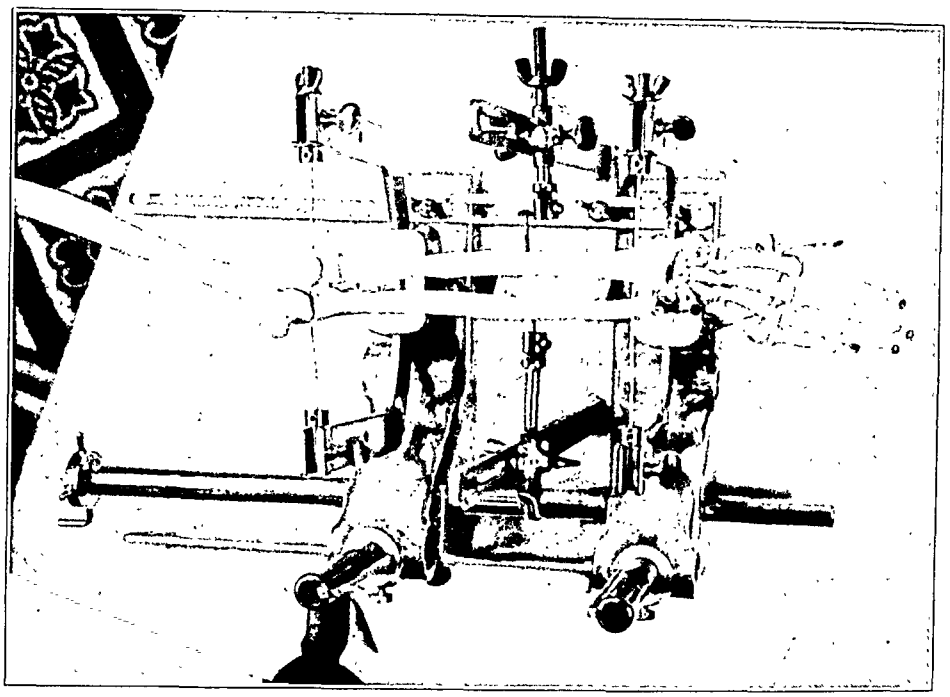


FIG. 5

Fracture frame with the author's screw-traction device attached.

so as to allow some motion at the joint; the olecranon wire was untouched. Roentgenograms taken at two-week intervals showed a rather slow formation of callus, but maintenance of the good position of the fragments. At the end of ten weeks the wires, screws, and cast were removed without any anaesthetic. A light anterior splint was worn for a few weeks more, just as a protection, and the patient was instructed to begin active motion of the involved parts. Four and one-half months after reduction he had normal use of all the joints of the left upper extremity. No deformity could be seen or felt. (See Figure 4.) The only signs of treatment were the small scars left by the wires and screws.

Figure 5 shows the additions to the fracture frame which the writer has made for handling such a case in the future. The adjustable screw-holding arms can be put into any position and they absolutely immobilize the fragments for the taking of roentgenograms and the application of the plaster cast. One of the troublesome features in the case described was the manual holding apart of the upper fragments.

The author feels that this method should be tried in all such cases which usually are subjected to operative means of reduction and retention.

# OSTEOMYELITIS OF THE PATELLA

## Report of Two Cases

BY R. J. DITTRICH, M.D., FORT SCOTT, KANSAS

*From the Orthopaedic Service of Mercy Hospital*

Primary hematogenous osteomyelitis of the patella is such an uncommon affection that our knowledge of it is gained almost entirely from the study of single cases. In many instances the diagnosis of this condition is not clear until a septic arthritis of the knee joint has occurred by extension of the destructive process. In the majority of cases the course of the infection is acute, and the involvement is so extensive that all or most of the patella is extruded in the form of sequestra.

Case 1. L. D., white male, aged twelve years, was seen on January 15, 1935. In December 1933 he had injured the left knee when he stepped into a hole in a porch. There was no abrasion of the skin, but considerable pain and mild swelling were noted in the anterior portion of the knee. A splint was applied by the family physician. After several weeks this was removed, and the knee was swollen, painful, and tender. The condition improved gradually but always remained somewhat painful, especially on walking. A few weeks before examination the pain became more severe and a decided limp developed.

Examination of the knee showed a moderate swelling over and around the patella with a mild degree of tenderness, most marked over the patella but involving also the joint line anteromedially and anterolaterally. There was a mild effusion into the joint. Motion was practically complete and produced very little pain.

The patient was admitted to the hospital two weeks later. At this time there was an increase in the swelling and heat over the patellar region. Motion was free but painful on extreme flexion. No abnormal mobility was noted. There was definite tenderness over the patella, mostly in the lateral and superior portions. The patella was freely movable. Mild tenderness was present along the upper margin of the tibia anteromedially. The effusion in the joint had increased somewhat since the the first examination, but was entirely painless. Except for hypertrophied and chronically infected tonsils, the patient had no other abnormalities.

Urine examination showed nothing abnormal. The leukocyte count was 12,000.

Roentgenographic examination (Fig. 1) showed an irregularity of the contour of the lateral and superior borders of the patella, atrophy and cavitation of the anterior two-thirds, and a proliferative periostitis of the anterior surface.

A diagnosis of osteomyelitis was made, and an operation was performed on February 9, 1935. A median longitudinal incision was made; the periosteum was reflected; and, with mallet and osteotome, the anterior portion of the patella was removed down to the cavities, one in the medial and one in the lateral portions of the bone. The cavities were from five to seven millimeters in diameter and contained soft, grayish degenerated tissue, mucopurulent in character. This material was removed with a curette. Due to the low virulence of the infection, it was decided to do a primary closure of the wound.

Bacteriological examination showed a profuse growth of staphylococcus aureus.

The report of the pathological findings by Dr. C. A. Hellwig follows: "Grossly the bone appears partly necrotic and hemorrhagic. Microscopically, the cartilage shows deep fissures at the surface and the matrix shows degeneration. Most of the bone trabeculae have well-stained bone cells. There are a few spicules without definite nuclear



FIG. 1

Case 1. Roentgenogram of patella before operation, showing cavities in both the medial and the lateral portions.

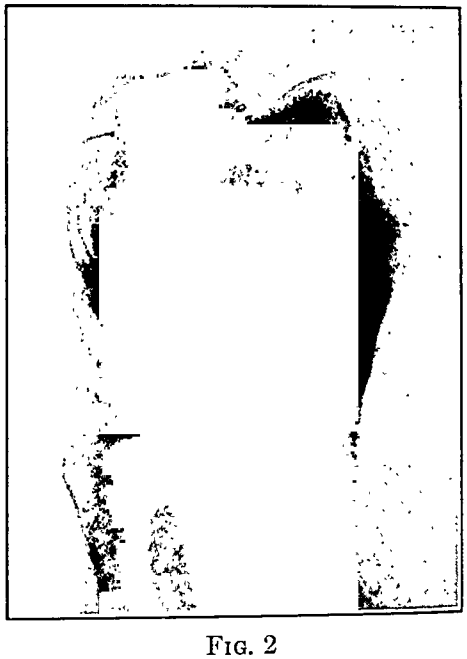


FIG. 2

Case 1. Roentgenogram taken two years after operation, showing regeneration of bone.

stain. There are also small areas where new bone trabeculae are found. The bone tissue is replaced in many areas by fibrous tissue which is cellular and infiltrated with plasma cells and a few leukocytes. No definite abscesses are found. Pathological diagnosis: Subacute osteomyelitis."

Following operation the patient's temperature continued a septic course (98.6 to 102.6). Considerable swelling appeared along the incision, and small amounts of pus were discharged, necessitating removal of the sutures. In addition, the knee joint was distended gradually by effusion which was painless and evidently aseptic.

On February 27, 1935, the joint was aspirated and seventy cubic centimeters of clear greenish fluid were withdrawn. Roentgenographic study on the same day showed that a portion of the patella involved in the destructive process was still present, and this, together with the other findings of a progressive condition, indicated that further operative measures were necessary.

The next day the wound was opened down to the bone. The anterior surface of the bone consisted of soft friable bone and granulation tissue. In removing the affected portions of bone along the lateral border of the patella, an opening was accidentally made into the joint, allowing about twenty cubic centimeters of greenish fluid to escape into the wound. The wound was packed lightly with vaselin gauze.

Following this procedure, the temperature rose to 100.2 degrees on the second and third days, and then returned to normal. The amount of drainage decreased from day to day. On March 16, 1935, the vaselin gauze was removed. After ten days the drainage ceased, there was no tenderness or effusion of the joint, and motion was possible from 90 to 180 degrees. The patient had a complete return of function which was in all respects normal. A roentgenogram (Fig. 2), taken in April 1937, showed a satisfactory regeneration of the patella.

CASE 2. R. C., white male, aged fifteen years, was seen on May 7, 1937. During the previous six months he had had occasional mild pain in the right knee. This was never severe enough to incapacitate him for ordinary activity, although the knee was quite painful whenever it was injured. Disability was most prominent during gymnastic exercises at school. He could recall a number of injuries to his knee, although there had never been any abrasion of the skin or any swelling of the joint.



FIG. 3-A

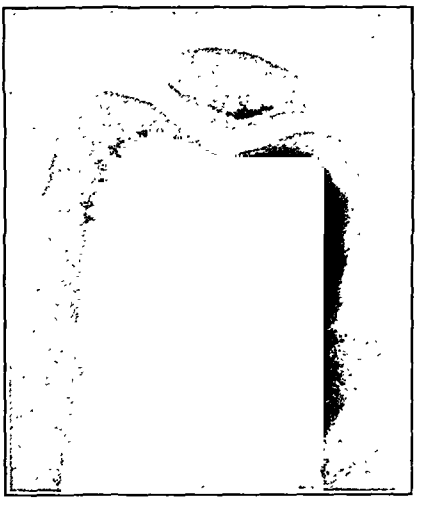


FIG. 3-B

Case 2. Roentgenograms showing small area of destruction on posterior surface of patella.

The patient had complete range of motion in flexion and extension. There was no disturbance of gait, no swelling, and no effusion. Mild tenderness over a small area medial to the patella constituted the only positive finding.

Roentgenographic study (Figs. 3-A and 3-B) showed a small cavity on the posterior aspect of the patella. This was oval in shape and surrounded by a layer of condensed bone.

A diagnosis of osteomyelitis was made. From the clinical course it appeared that this was at the time a benign process, although potentially dangerous. For that reason it was considered advisable to remove the focus.



FIG. 4

Case 2. Roentgenogram taken ten weeks after operation, showing healing of bone.

Operation was undertaken on May 14, 1937. After the anterior surface of the patella had been exposed, a drill hole was made anteriorly. This was enlarged with a burr. After the desired depth had been reached, the cavity was located with a small drill. The contents of the cavity consisted of dense fibrous tissue and soft granulation tissue. No pus was found. The margins of the cavity were removed with a curette. The wound was packed lightly with vaselin gauze.

Bacteriological examination showed no culture.

The report of the pathological findings by Dr. C. A. Hellwig read as follows: "There are fragments of bone with hemorrhagic and inflammatory changes. In one area there is noticed a necrosis of bone spicules surrounded by leukocytic infiltration of the bone marrow. Diagnosis: Osteomyelitis."

Following operation there was a moderate amount of drainage, which decreased from day to day. After two weeks the drain was removed. Three weeks later the wound was healed. At the time when this report was written, the patient had been ambulant




FIG. 3

Case 1. Preoperative spine-marker roentgenogram, with patient in wedging jacket.

# FRICTION VERSUS TRACTION

## A Simple Appliance for Use in Making Traction to the Head

BY ALBERT H. FREIBERG, M.D., CINCINNATI, OHIO

*From the Department of Orthopaedic Surgery, University of Cincinnati Medical School*

Maximum efficiency in applying traction to the head or to the extremities is to be attained only by eliminating as far as possible the element of friction. By this is meant not simply friction in the mechanism itself, but, what is much more important, friction between the head or extremity and the surface of the bed upon which it rests. Failure to recognize this fact and to make provision for it has resulted only too often in dissatisfaction with the method or in the unnecessary and undesirable elaboration of apparatus and even of the plan of treatment.

The author has long held the opinion, as the result of experience, that the sole virtue of the Russell (so-called "Australian") method of traction to the lower extremity lies in holding the extremity suspended, so that friction is thereby rendered inoperative. This can be demonstrated by suspending the extremity in a sling from an overhead frame and by making traction at any desirable angle in the ordinary manner. The limb swings comfortably like a pendulum, and friction against the bed surface is completely eliminated. The weight of a leg in a number of adult males has been ascertained by means of an accurate spring balance, and it has been found to vary between fifteen and eighteen pounds. It follows that in practice this much weight must be used merely to overcome the friction factor before the tractive effect becomes evident at the desired point on the limb. This amount of weight is not only superfluous, but, when adhesive plaster is used, it causes the plaster to slip and to irritate the skin unnecessarily. While this method cannot compete in mechanical efficiency with traction upon bone by the insertion of metal pins, skeletal traction constitutes a complication which is frequently both undesirable and unnecessary, especially when hospital care is not feasible. However, even when skeletal traction is employed, that amount of force which must be used merely to overcome friction is wasted and undesirable if it can be shunted out altogether.

The heads of fifteen recumbent male patients and of an equal number of recumbent female patients were weighed with the spring balance by Dr. William A. Bishop, Jr., the Orthopaedic Resident at the Cincinnati General Hospital. While there was some variation in weight according to size, the average weight was eight and one-half pounds. The heads of a number of children below the age of twelve were weighed in the same manner. The average weight of the head in patients between the ages of five and twelve was six and one-half pounds, although the variation was

for five weeks, without any return of symptoms. There was no swelling, tenderness, or restriction of motion.

Roentgenographic examination (Fig. 4), on July 26, 1937, showed practically a complete regeneration of the bone with no evidence of destructive process.

## DISCUSSION

In both of the cases reported the symptoms had been of long duration. They were mild in character; in fact, they were so inconspicuous that one would hardly suspect the true nature of the disease. From the roentgenographic appearance, it is also evident that the destructive process had been of long duration. It is possible that in some of the cases with an acute course a chronic infection has been present for some time previous to the acute onset. This is especially to be suspected in those cases in which complete sequestration of the bone occurs early in the course of the disease.

It is to be expected that a chronic focus of destruction, which is well defined in the roentgenogram, even though it is mild symptomatically, will not indefinitely continue a benign course but will eventually become active. With this in mind, it is considered advisable, when the diagnosis is clear, to eliminate the destructive process while it is still in the chronic stage.

the rollers will tend to move toward the lower or foot end by gravity. The head should rest upon a thin pillow of about the same size as the top board. (See Figure 2.) Like every other similar appliance, it requires occasional inspection during use in order that it may be kept continuously effective. The rollers must be prevented from impinging upon their upper barriers and this will be apparent even to an untrained person.

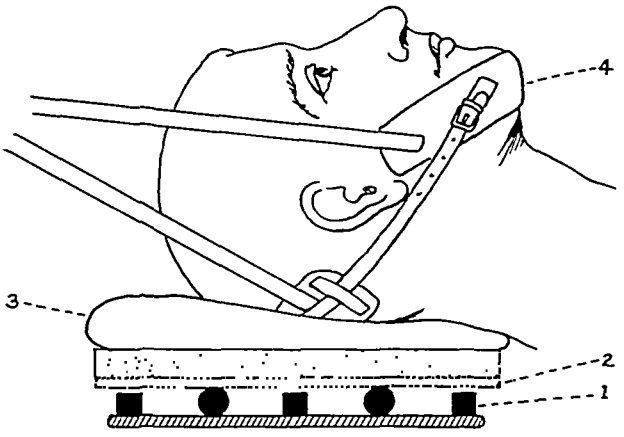



FIG. 2

Vertical section of the apparatus in use: *1*, the tray; *2*, the top resting upon the rollers and covered with layer of sponge rubber; *3*, small pillow of the same size as the top; *4*, the halter, which should impinge upon the chin and not upon the neck.

Experience with this appliance has shown two factors of no little importance. Since it is not necessary to employ about eight pounds of force to the heads of adults and correspondingly less in children, merely to overcome friction, the problem of a comfortable halter has become greatly simplified, even to the point of being non-existent. As a matter of fact, this involves the second factor,—we have found it unnecessary to use as much weight for effective traction as we were compelled to employ, by the old method, to overcome friction alone. Under continuously effective traction, not nearly as much weight is required as we had before thought necessary. The weight which we have employed with this apparatus has varied between three and six pounds. This much weight is easily tolerated even with a halter improvised out of muslin bandage. It has also been found practical to make the head halter out of washable material.

The appliance described has been used both for children and for adults, and for traumatic conditions as well as for disease of the cervical spine. It has given satisfaction in the hands of others, as well as in those of the author. It is applicable not only in hospital practice, but also under quite adverse circumstances.

The author is indebted to Mr. Joseph Homan of the Department of Medical Art for his kindness in furnishing the illustrations.

greater than in adults. If the weight of the head rests upon bed and pillow, as has been the usual practice in the past, a corresponding amount of force must be applied to the head merely to overcome friction and before the cervical spine is subjected to the tractive effect in any adequate degree. This is true even with the insertion of pins into the skull for skeletal traction, and the use of this much force merely to suspend the head fulfills no other useful purpose. In the case of traction to the head for lesions of the cervical segment of the spine, however, it has been found that great force is seldom, if ever, necessary provided always that the force is efficiently applied.

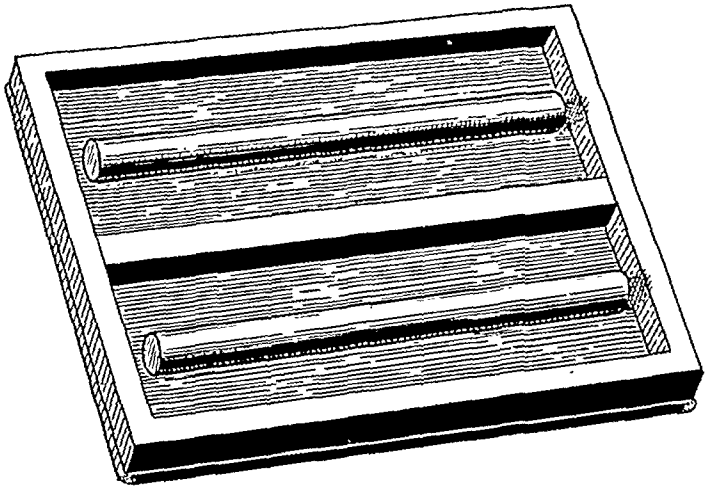


FIG. 1

The tray, containing the two dowel cylinders, as seen from above.

The simple appliance which is shown in Figures 1 and 2 is offered as a means of reducing friction to a minimum. It can be easily and rapidly improvised in any ordinary shop, since it requires only such materials as are everywhere obtainable. The author has used it with great satisfaction for several years.

The appliance (Fig. 1) consists of four separate pieces made of wood:

1. A tray, eight by ten inches, made of thin wood; so-called "plywood" is preferable, but not indispensable. To the four sides of its upper surface is fastened a rim of wooden strips, one-half an inch in height and in width, and the tray is divided into two equal compartments by another strip, of the same dimensions, placed transversely.

2. Two dowel pins (wooden cylinders) cut to such a length that they will roll easily in each compartment. Each pin should be five-eighths of an inch in diameter, so that it projects slightly above the height of the rim of the tray.

3. A top of plywood or other thin wood, ten by ten inches, on which the head is to rest. To the upper surface of this there may be glued a pad of sponge rubber, a so-called kneeling pad such as may usually be found in the "five-and-ten-cent" store. This pad is not indispensable, but it adds much to the patient's comfort as well as to the efficiency of the apparatus.

When the top is placed upon the rollers, it will move to and fro with friction reduced to a minimum, because the rollers are somewhat higher than the rim of the tray. In use, the appliance is placed under the patient's head with its upper end slightly higher than the lower, so that

admission as having satisfactorily recovered. The use of autogenous vaccine in the treatment of systemic diseases of bacillus-pyocyaneus etiology was reported by Wassermann as early as 1896 and is still accepted as the most advantageous attack on the inroads of pyocyaneus infection in internal organs and in concealed tissue spaces.

## CASE REPORT

R. B., a well-developed and well-nourished white male, aged three and one-half years, was admitted to the Orthopaedic Service of the Cincinnati General Hospital on February 2, 1937, with a swollen and painful right ankle.

Fifteen months previously, on November 11, 1935, he had been admitted to the Dermatological Service with first and second degree burns involving about one-fourth of the body surface, including the right leg and foot. By the fourth hospital day, there had developed a rather severe pyodermia of the involved area with evidence of bacillus-pyocyaneous infection. Three weeks after entry, multiple subcutaneous abscesses had appeared, including one over the insertion of the Achilles tendon on the right. Roentgenograms of the right ankle were negative. A culture of the pus obtained at the time of incision and drainage showed, among other organisms, bacillus pyocyaneus. The temperature curve rose again ten days later, at which time repeated roentgenograms showed beginning destruction of the lower tibial epiphysis on the right. An incision and drainage of the ankle was done at that time, but, unfortunately, the pus was not cultured. The patient was discharged from the hospital on the 114th day after entry, March 3, 1936, as having recovered sufficiently to walk unassisted. He was to be followed in the Out-Patient Department, but he did not return.

On readmission, his mother gave a history of his having had pain in the right ankle and a limp of about one week's duration. Three days before admission, redness and swelling of the joint had developed; this was associated with an elevation of temperature and night sweats. The mother stated that for several weeks after leaving the hospital fifteen months previously, the patient had walked with a limp, but that this had completely disappeared and for the past year he had had no complaints.

Examination at the time of his second admission revealed a well-developed and well-nourished white male infant who was obviously acutely ill, but only moderately toxic. There was swelling of the right ankle with redness of the overlying skin and increased local heat. Fluctuation was present below and anterior to both malleoli. Saphenous and femoral lymphadenopathy was quite obvious on the right side.

Incision and drainage of the right ankle joint was done under strict aseptic technique, and yielded a small amount of thick bluish-green pus. On smear and culture, only S-shaped rods of bacillus pyocyaneus were found. An autogenous vaccine was made, small doses of which were given intradermally on alternate days.

The cast was changed on the thirtieth day after admission, at which time the wound was well healed, and there was but little tenderness. The patient was discharged to the Out-Patient Department where vaccine therapy was continued for one month.

## SUMMARY

In this case, the bacillus-pyocyaneus infection developed in an area of first and second degree burn of the leg. Subsequently, the infection involved the soft tissues about the ankle joint, followed by roentgenographic evidence of destruction of the distal tibial epiphysis on the right. Fifteen months after recovery, a pyarthrosis of the same ankle developed, from which a pure culture of bacillus pyocyaneus was obtained. Recovery ensued after incision and drainage of the ankle and autogenous-vaccine therapy.

# A CASE OF PRIMARY BACILLUS-PYOCYANEUS ARTHRITIS IN AN INFANT

BY W. A. BISHOP, JR., M.D., CINCINNATI, OHIO

*From the Department of Orthopaedic Surgery, University of Cincinnati Medical School*

Primary systemic infection by the bacillus pyocyaneus is sufficiently infrequent to merit discussion. This organism is usually considered as having a low pathogenicity, manifesting its presence occasionally as a secondary invader in localized pyogenic processes. It is found as a secondary invader in such conditions as furuncles, infected wounds, etc., most frequently being considered a nonpathogenic parasite.

The bacillus pyocyaneus was first obtained by Gessard, in 1882, in pure culture from two cases of skin wounds showing bluish-green discoloration. Not long thereafter, the organism was found by numerous investigators in colored suppurations in various portions of the body. By 1897, the organism had been repeatedly found not only in open wounds, but also in generalized infections with severe constitutional symptoms, as reported by Baker.

In a review of the literature in 1906, Rolly collected a series of cases of infections of internal organs in which the bacillus pyocyaneus was either the sole or an associated invader. In this list were such diseases as perityphlitis, pyelonephritis, mastitis, and panophthalmitis; a case of prepatellar bursitis; and cases in which fistulae were present.

In a study of 12,000 autopsies, Fraenkel concluded that the bacillus pyocyaneus was the principal invader in only thirteen cases. In 1917, he presented a study of twenty-six cases of primary pyocyaneus invasion in which there were twenty-one children under two years of age and five adults. He observed cases of otitis, enteritis, ecthyma gangraenosum, endocarditis, meningitis, sepsis, and others, due directly to infection with this organism. He concluded that it may act not only locally with the production of toxin, but also through the actual invasion of internal organs; and he expressed the belief that, although this organism was rarely the primary cause of disease, nevertheless, the majority of such pyocyaneus infections were acute and fatal almost without exception. The later articles concerning bacillus-pyocyaneus infection in man add nothing to this classical description.

Although many instances of infection have been reported in which the bacillus pyocyaneus was the principal invading organism, a search of the literature revealed but one reference to primary joint involvement. This case was reported by Pinelli and was that of an eight-month-old infant with arthritis of the left shoulder from which was isolated a pure culture of the bacillus pyocyaneus. The patient was treated with autogenous vaccine, and was discharged from the hospital two weeks after

# A SPECIAL BONE RETRACTOR FOR SUBTALAR ARTHRODESIS

BY WILLIAM H. VON LACKUM, M.D., F.A.C.S., NEW YORK, N. Y.

*From the New York Orthopaedic Dispensary and Hospital*

The technical difficulties frequently encountered in obtaining satisfactory exposure and visualization of the talocalcaneal joint in doing a subtalar arthrodesis have led to an effort to simplify this step in the procedure.

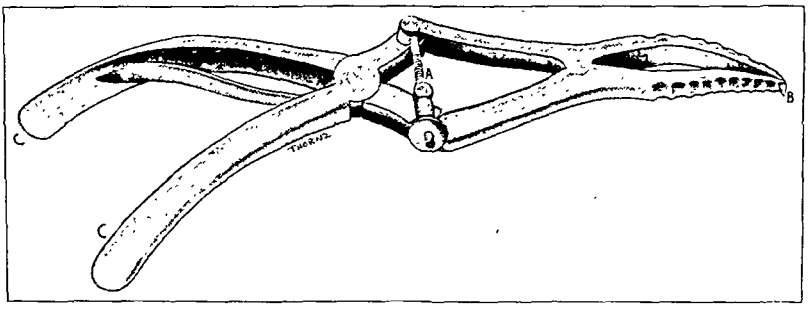



FIG. 1

Bone retractor, improvised from a Hamilton-Cook uterine dilator, for use in subtalar arthrodesis:
*A:* Adjustable lock screw.
*B:* Steel pegs.
*C:* Handles rotated 180 degrees.

For this purpose, a Hamilton-Cook uterine dilator has been converted into a partially self-retaining retractor, as seen in Figure 1, by rotating the handles 180 degrees, and by applying an adjustable retaining screw and bolt to the handle, and sharp steel pegs to the tips of the blades. When in position, as shown in Figure 2, the instrument opens widely this hitherto relatively inaccessible talocalcaneal joint, so that the joint surfaces may be well visualized, thus greatly facilitating the clean excision and reshaping of the joint surfaces.

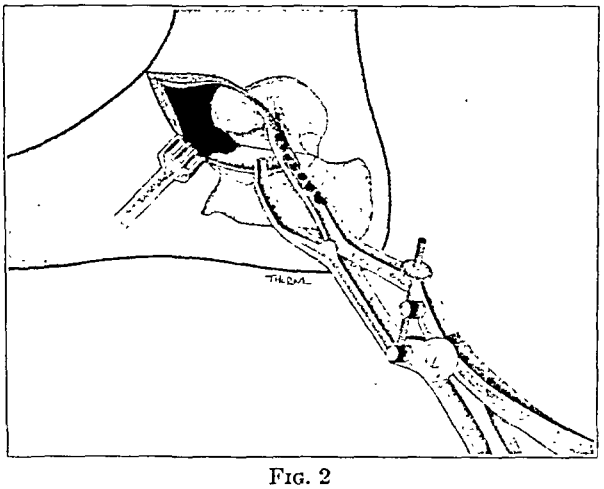


FIG. 2

Retractor in place, showing the talus and os calcis wedged apart laterally. The articular surfaces are thus made accessible for excision.

This instrument is particularly helpful in performing arthrodeses on immobile, arthritic, or post-traumatic feet, in which the talocalcaneal joint is involved. It has also been used to advantage in exposing the articular surfaces in fusion of the ankle joint.

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FIG. 4

Case 1. Three years after operation, with patient standing.

# A NEW KNIFE FOR USE IN REMOVING SEMILUNAR CARTILAGES

BY FRANK A. LOWE, M.D., SAN FRANCISCO, CALIFORNIA, AND LOUIS W. BRECK, M.D., EL PASO, TEXAS

In spite of the fact that the removal of a semilunar cartilage is a relatively common procedure for the orthopaedic surgeon, it is still a rather difficult one for many men, and occasionally even for the most dexterous. The hardest part of the procedure is the freeing of the cartilage from its attachment. Due to the fact that the condyles of the femur are in close apposition to the upper end of the tibia, there is very little space in which to work, even if a large incision has been used. With a small incision, it is perhaps even more difficult. The most common method of freeing the cartilage is by means of a pair of scissors, and usually it is somewhat hard to insert them along the lateral and posterolateral attachments of the cartilage and to bring them into play. The surgeon is often forced to make numerous attempts, and, when he has finished, an

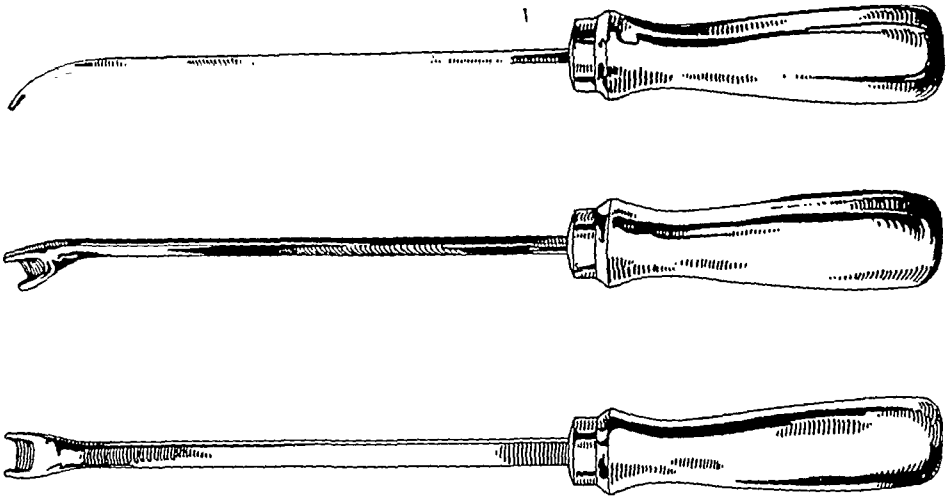


FIG. 1
Showing the construction of the cartilage knife.

irregular or serrated border of the cartilage is left and the removal is accompanied by more trauma than is desirable.

We have designed a knife to be used in removing semilunar cartilages which we have called the Lowe-Breck cartilage knife, and we believe it to be quite an addition to the armamentarium used in this procedure. It is essentially an end-cutting knife with small guides on the sides of the blade, and the end of the knife is curved to conform to the contour of the semilunar cartilage. Other end-cutting knives have been devised for this purpose, but we have been unable to find any knife similar to the one we are describing.

Figure 1 shows the general construction of the knife which consists of a handle, a shaft, and a curved end, on the tip of which is a knife edge with a small guide on either side. The shaft and end together measure six inches, so that the instrument is fairly long. The curve involving the terminal one and one-fourth inches permits the blade to follow the border of the cartilage, for its contour corresponds to that of the meniscus. Inasmuch as the contours of the medial and lateral menisci are almost the same, and since the instrument is symmetrical, it can be used as well for one cartilage as for the other. The end-cutting blade is effective and at the same time not dangerous, for the guides on each side prevent it from invading the tissues. The guides themselves are blunt and are not dangerous if handled with ordinary care.

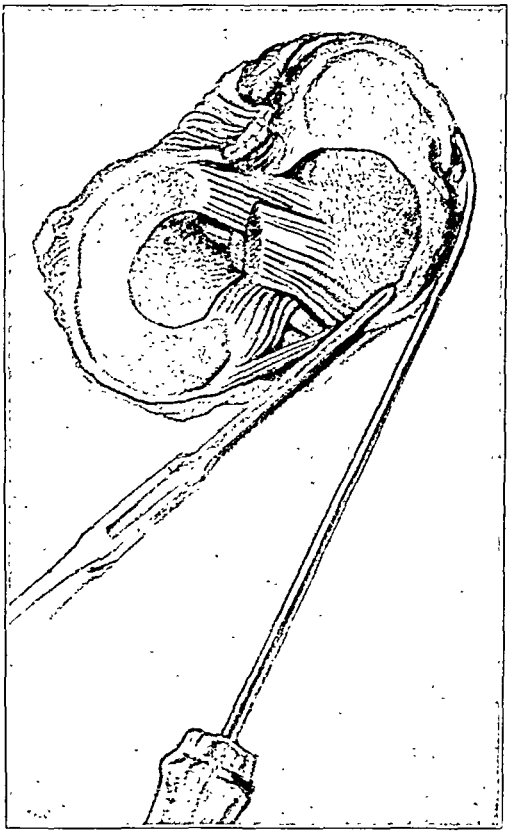


FIG. 2

Diagrammatic drawing showing the top of the tibia with the cartilage knife in place and the meniscus half removed.

If this knife is used, the operator may choose the incision which he has found most successful. The semilunar cartilage which is to be removed is identified, and its front end is grasped with a strong clamp and freed with scissors for a distance of one-half to one inch. The cartilage knife is then placed along the attachment of the meniscus at the end of the scissors cut. The knife is adjusted so that its curve is accommodated to the contour of the cartilage. Pressure is then exerted on the knife and, as it cuts, the attachment is followed around until the cartilage is free. Once the knife is placed properly and the cutting has been begun, it is usually quite easy to follow the border of the meniscus, for the cartilage cuts fairly easily and the guides on the knife hold it in place and prevent it from slipping. Figure 2 illustrates the manner in which the instrument is used and shows how the curve on the end of the knife fits the contour of the cartilage.

We have found the instrument very useful in a procedure which is not always easy, and we hope that others may find it equally valuable.

# PERONEAL-NERVE PALSY DUE TO COMPRESSION BY ADHESIVE PLASTER

BY SETH SELIG, M.D., NEW YORK, N. Y.

Adhesive traction as described by Russell[1] has become increasingly popular as a method of treating fractures of the shaft of the femur. While the physics of this method has been thoroughly described, little attention has been given to the technique of applying the adhesive to the leg. In any method in which traction is used, constant vigilance and frequent adjustments are necessary to maintain the efficiency of the method and to avoid complications.

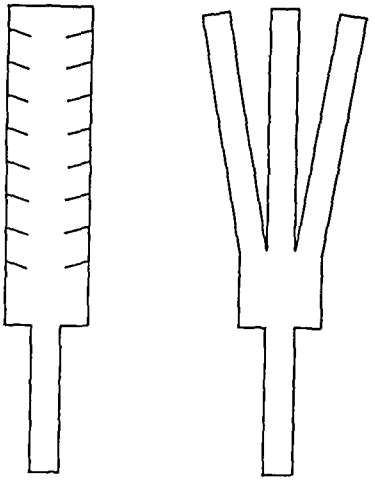


FIG. 1

The two most common methods of applying adhesive traction strips to the lower extremity. Anchoring strips, whether transverse or oblique, are not shown in this illustration and may be dispensed with.

Recently five cases of pressure neuritis of the common peroneal nerve, caused by improperly applied adhesive plaster, have come to the writer's attention.

In two of the cases the adhesive had been applied for the purpose of making traction according to the method of Russell. One patient was a woman, seventy-nine years old, with an intracapsular fracture of the neck of the femur fixed by a metal screw, and Russell traction had been applied as an added safeguard. At the time of her death from an infected decubitus ulcer, six weeks after the peroneal palsy had been noticed, there was no improvement in the neurological condition. The second case of peroneal palsy occurred in a nine-year-old boy suffering from a hemolytic-streptococcus infection of one hip which was treated in Russell traction. The nerve symptoms disappeared in six months. Both patients had complained of pain in the foot and along the anterior aspect of the leg for from one to seven days before paralysis appeared, and the pain was erroneously ascribed to the hip. The neuritis was due to direct pressure by a transverse strip of adhesive used as an anchor for the longitudinal strips, crossing the upper end of the fibula and compressing the common peroneal nerve against the bone.

In two cases the peroneal-nerve palsy followed continuous intravenous injection into one of the leg veins as a postoperative therapeutic measure. The neuritis in these cases was also caused by pressure of one of the transverse adhesive strips with which the extremity had been strapped to an immobilizing board.

A fifth case of common peroneal-nerve palsy occurred after arthrot-

omy of the knee joint for removal of a torn internal semilunar cartilage. The dressing was held in place by two strips of half-inch adhesive that encircled the extremity; the lower strip crossed the upper end of the fibula and compressed the common peroneal nerve.

While there are many methods of applying adhesive traction, the two most common ones are illustrated in Figure 1. In both methods it is customary to apply oblique or transverse adhesive strips to anchor the longitudinal ones. Over all of these strips a bandage, preferably of the elastic type, should be applied. Care must be taken to avoid placing

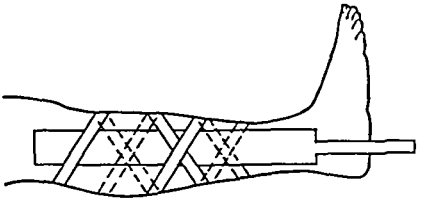


FIG. 2-A

Improperly applied traction. The oblique anchoring strips cross the fibula near its upper end where there is danger of injuring the common peroneal nerve.

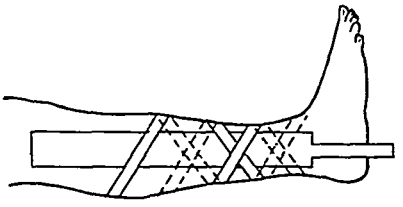


FIG. 2-B

Properly applied adhesive in which no transverse strips cross the upper three inches of the fibula. The transverse strips may be dispensed with.

either the transverse or the oblique strips across the upper three inches of the fibula, because it is at this point that the peroneal nerve is superficial and readily compressed against the underlying bone. (See Figures 2-A and 2-B.)

Care must also be used in applying the distal, transverse, or oblique turns of adhesive which pass over the anterior aspect of the ankle joint. If these have been applied too tightly or too near the dorsum of the foot, the inevitable slipping of the side strips causes them to cut into the soft parts.

Any complaint of pain in the leg or foot in a patient with adhesive traction or dressings about the knee joint should be carefully investigated. This also applies to cases in which the limb has been immobilized in a plaster bandage, as we are all familiar with common peroneal-nerve palsy due to pressure of a plaster bandage over the upper end of the fibula.

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# AN ADAPTATION OF THE BALKAN FRAME FOR DEVELOPING MOTION AND ABDUCTION OF THE HIP

BY PAUL L. NORTON, M.D., AND FRED ILFELD, M.D., BOSTON, MASSACHUSETTS

*From the Orthopaedic Service of the Massachusetts General Hospital, Boston*

The traction-suspension apparatus described here was evolved primarily to meet the need of early mobilization of the hip joint following surgery, particularly acetabuloplasties and arthroplasties.[2]

In these particular operations, early motion in flexion and abduction is essential to a successful result. The ordinary traction-suspension de-

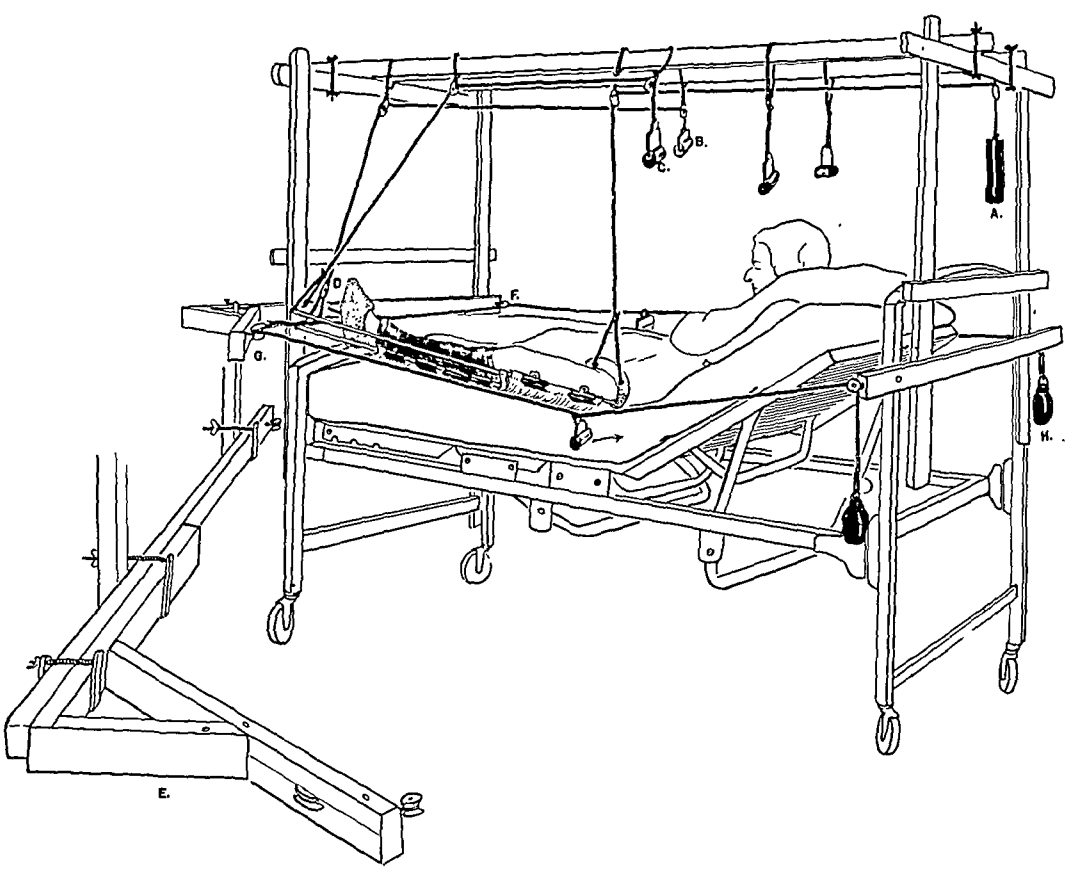



FIG. 1

vice allows adequate flexion of the hip, but does not permit enough abduction. With a Balkan frame as the foundation, the ordinary type of traction-suspension has been modified to allow wide abduction. The apparatus has been used in over forty-five cases of hip-joint surgery, but its use need not be restricted to that particular joint.

Passive hip motion in flexion and abduction is started in traction-suspension on the third or fourth day postoperatively, and usually by the end of the first week the patient is encouraged to try active move-

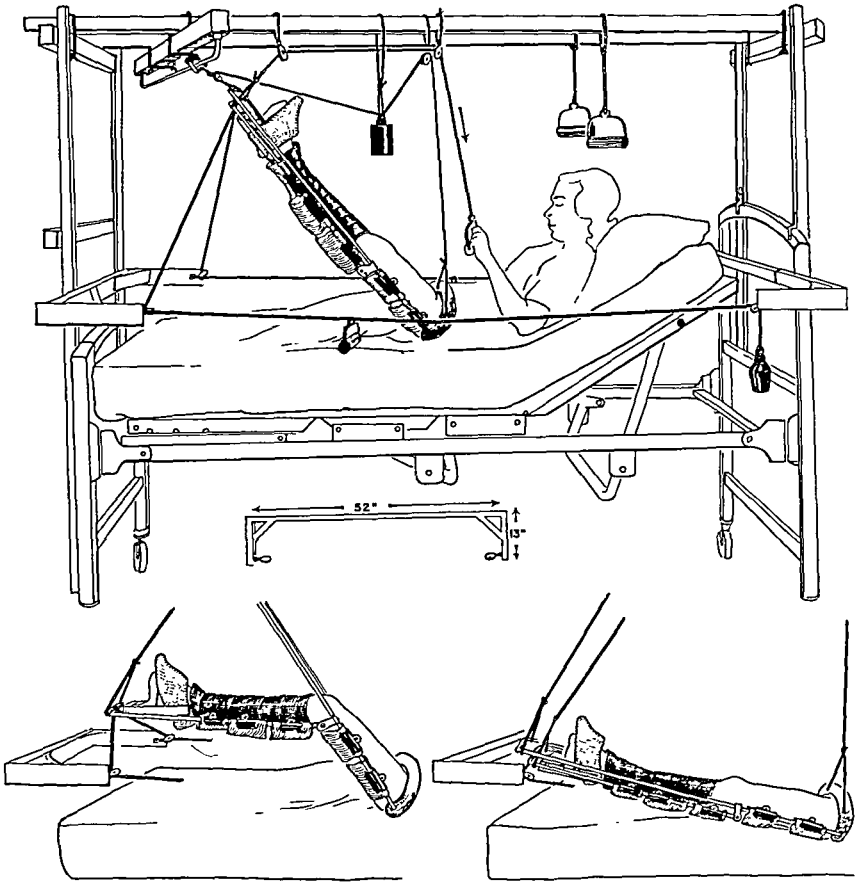



FIG. 2

ments. The motions of abduction, flexion, and knee extension are stressed. At the end of two or three weeks the apparatus is removed and the patient is allowed up in a walker for one week and is discharged walking with crutches.

Figures 1 and 2 illustrate two types of traction-suspension both hung from the standard Balkan frame. Any hospital treating fractures or special orthopaedic cases will have the necessary articles for setting up this device.

After moleskin adhesive has been applied to the lower leg, a Hodgen splint with a Pierson attachment is fitted to the extremity. Traction is maintained by a piece of tourniquet rubber tubing tied to the end of the Pierson attachment and fixed to a footpiece (omitted in the drawing). A three-pound weight, hung over the end of the bed on a swivel pulley, may also be used. If heavier traction is indicated, a Thomas ring splint should be used in place of the Hodgen splint.

The ring end of the splint is held in place by a ten-pound weight (*A*) and the distal ends of the Pierson attachment and the splint are controlled by ropes leading to the handles (*B* and *C*).

A pulley (*D*) is placed on the rope fastened to the lower end of the Pierson attachment. This pulley allows greater lateral motion and keeps the splint from rotating.

A Russell-traction endpiece is fastened onto a crossbar as shown in the insert *E*. Ropes then run from each side of the Pierson attachment through the lateral pulleys (*F* and *G*) to a crossbar at the head of the bed where they attach to three-pound weights (*H*) pulling through a second set of pulleys.

Handles are placed on these lateral ropes so that by pulling on them the patient may abduct or adduct the leg.

Traction on *B* flexes the hip with the knee extended. Traction on *C* flexes the hip and the knee. The hip may be flexed by pulling on *C* while the knee is passively flexed and extended by means of alternating traction on *B*.

The type of apparatus in Figure 2 may be arranged more quickly and allows easier lateral motion. The leg is placed in a Hodgen splint in traction and balanced with a five-pound weight. The assembly is suspended from a standard Balkan frame. The distal end of the splint is attached to a pulley which moves on a steel bar *; this allows wide abduction. The lateral ropes are run through pulleys on a special crosspiece as shown in the drawing. Flexion and extension of the knee are illustrated in the lower diagrams. Abduction of the hip is routinely performed in varying degrees of flexion.

* The bar is made of one-half inch cold rolled steel and is bolted to a piece of joist four feet long and one inch by one and three-quarter inches in cross-section. The distance between the joist and the rod is two and one-half inches.

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2. Smith-Petersen, M. N.: Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana by Means of Acetabuloplasty. J. Bone and Joint Surg., XVIII, 869, Oct. 1936.

# A TRACTION APPARATUS FOR FRACTURES OF BOTH BONES OF THE FOREARM

BY EDWARD N. REED, M.D., SANTA MONICA, CALIFORNIA

The apparatus shown in Figure 1 was developed to overcome the awkwardness of the Soutter reduction apparatus when applied to forearm fractures.

## CONSTRUCTION

The bases which screw on the table are made of boiler plate, folded to form a channel; one side of each base is drilled and threaded for thumb screws. The uprights are made of flat crucible steel, 12 or 14 gage, bent to shape and riveted into the bases. The screws are threaded steel rods which run through a short piece of Shelby tubing that projects far enough to form a shoulder against which the winged nut bears. On one side, the screw of an ordinary C clamp, four or five inches in length, is used because the pitch of the thread is steep and the screw is, therefore, rapid

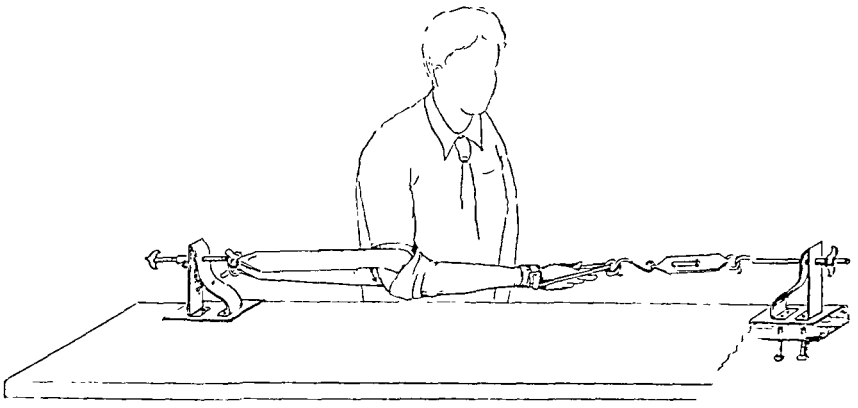


FIG. 1

in action. The end of the C clamp which carries the screw is sawed off with a hack saw, drilled, threaded, and mounted on the upright with machine screws. The swivel cap which is standard on the end of the C-clamp screw is drilled and threaded, and a crosspiece is fastened to it with machine screws to give attachment to the rings at the ends of the cuff straps. The wrist cuff is made of soft leather, it encircles the wrist twice, and it is fastened with a buckle. At the elbow, soft webbing is applied in the figure-of-eight manner.

## TECHNIQUE

By means of this apparatus, graduated traction is applied for regular periods of time with a relaxation interval of two or three minutes every

five minutes. Fifteen pounds of traction is used at first and this is increased by five pounds at each period, as recommended by Dr. Soutter. After twenty to thirty minutes, muscle relaxation is usually complete, and there is an interval of six or eight minutes during which the fragments can be manipulated into position.

After the position of the fragments has been checked with the fluoroscope or roentgenograms and found satisfactory, a circular cast is applied from the elbow cuff to the wrist cuff. This is carefully molded over the dorsal and ventral interosseous spaces in an attempt to maintain separation of the radius and the ulna. When this part of the cast has thoroughly set, the traction is released, the cuffs are removed, and the plaster is continued up over the elbow to the middle of the upper arm, and down over the wrist to the heads of the metacarpals.

## ADVANTAGES

The apparatus can be attached to any table in a few moments by four thumb screws. Since it is fixed to a table, it is steady. It holds the arm up from the table, permitting the taking of roentgenograms or the use of the fluoroscope and the application of a plaster cast over the greater part of the forearm, while maintaining traction. Detached from the table, it weighs only a few pounds and can be packed in a small box.

# NEW TECHNIQUE IN THE TREATMENT OF FRACTURES OF THE FOREARM *

BY LELIO ZENO, M.D., ROSARIO, ARGENTINE REPUBLIC

Fractures of the forearm, Colles' fracture, and fractures of the diaphysis of either radius or ulna, or of both bones, may be reduced by traction on the hand with flexion of the elbow to a right angle, allowing countertraction of the arm. One or more assistants are needed, and the surgeon cannot always be sure that proper traction and countertraction are maintaining the fragments in a satisfactory position while the plaster-of-Paris bandage is being applied. Sokolowsky of Warsaw has devised an apparatus which simplifies this procedure. (See Figures 1-A and 1-B.) Reduction of the fracture fragments in the corrected position is maintained and, at the same time, the bandage can be applied with ease. The apparatus may also be used for fractures of both bones when the direct open operative method has been undertaken to obtain a more effective reduction.



FIG. 1-A

Sokolowsky's appliance for reduction of fractures of the forearm.

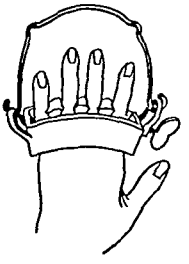


FIG. 1-B



FIG. 2-A



FIG. 2-B

Fixation by skeletal pins in plaster.

The difficulty of adequate steadying of an oblique fracture of the forearm, or of a comminuted intra-articular Colles' fracture, is well known,

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 3, 1937.

even when plaster splints are employed without padding. For these cases Böhler suggests combined fixation by means of a plaster-of-Paris dressing and two non-rusting wires passed through the bones and pulled taut, their ends embedded in the plaster. This steadying combination, a decidedly efficient one, is made easily and neatly with the aid of Sokolowsky's apparatus. (See Figures 2-A and 2-B.)

## Correction

Dr. Leo Mayer of New York has requested that we publish a correction in his article entitled "The Importance of Early Diagnosis in the Treatment of Slipping Femoral Epiphysis", published in *The Journal* for October 1937. On page 1051, the eleventh line in the third paragraph should read: "The leg is then immobilized in plaster-of-Paris in a position of abduction and internal rotation."

## PERCY WILLARD ROBERTS

1867–1937

Percy Willard Roberts passed away on November 8, 1937, at the Hospital for the Ruptured and Crippled, after an illness of only two days.

Dr. Roberts was born on January 10, 1867, in Janesville, Wisconsin, but he spent his early years in Milwaukee. At the age of eighteen, he went to San Francisco to become a reporter on the *Chronicle* and here earned his funds to study medicine. He graduated from Boston University School of Medicine in 1894. He then carried on a general practice in Bath, Maine, but, after ten years, the ambition to become an orthopaedic surgeon led him to New York in 1904, where he received an appointment at the Post-Graduate Hospital. The late Dr. Henry Ling Taylor recognized his ability and gave him an appointment at the Hospital for the Ruptured and Crippled in 1907, where he also worked under the late Dr. Virgil P. Gibney and on up through the various grades to Chief of a Division. He retired from active hospital work in 1934, but retained his private practice and was a consultant at many hospitals in New York.

Dr. Roberts contributed often to the literature and will be remembered for the operations and apparatus which he devised, as well as for his interest in the subject of congenital syphilis which made many realize that this disease was more often the cause of orthopaedic conditions than was formerly believed.

Dr. Roberts was always a kind gentleman, with a genial smile and a sense of humor, and was greatly admired and respected by his patients. He was always extremely mild-mannered, and even in the face of difficulties he appeared calm and unworried. Many times he went through various crises which must have perturbed him, but he never showed it outwardly. He was always loyal and cooperative and had a personality that would keep a group of men working together without friction. Those who worked with him and under him will feel a great loss in his passing.

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## EDWARD SPARHAWK HATCH

1875–1937

Edward Sparhawk Hatch, one of the outstanding orthopaedic surgeons of the South, died suddenly on October 20, 1937. He was born in Boston on February 2, 1875. He graduated from Harvard University in the Class of 1897 and from Harvard Medical School in the Class of 1899. He devoted a few years to general practice in Boston, but his interest soon turned to orthopaedic surgery. He became affiliated with Carney Hospital in Boston, and from that time dates his active part in this specialty.

In 1905 Dr. Hatch moved to New Orleans. He became a pioneer in orthopaedic surgery in that part of the South where he played an important rôle in the establishment of this specialty. In addition to an active private practice and to his work in research, he was Professor of Orthopaedic Surgery in the Post-Graduate Department of Tulane Medical School; chief of the Department of Orthopaedic Surgery in Tuoro Infirmary; and had also been chief of the departments of orthopaedic surgery in several of the medical institutions in New Orleans and vicinity. During the World War he served in the Medical Corps of the United States Army. Fifteen years ago Dr. Hatch opened the first clinics for crippled children in Lake Charles and Lafayette, Louisiana. He was still actively interested in the Clinic in Lafayette at the time of his death.

Dr. Hatch always took an interest and played an active part in the medical societies. He had been Chairman of the Orthopaedic Section of the American Medical Association, as well as of the Southern Medical Association, President of the Clinical Orthopaedic Society, and he was a member of the American Orthopaedic Association, the American Academy of Orthopaedic Surgeons, and a Fellow of the College of Surgeons.

In February 1937, Dr. Hatch suffered a fracture of the spine, but he did not allow this to interfere with his activity for after recovery he resumed and carried on his usual practice.

He was always a good friend, and his genial personality will be missed by his friends. He leaves a widow and two children,—a married daughter and a son.

*Case 1 (Figures 1, 2, 3, and 4)*

B. B., female, aged fourteen years, had an "idiopathic" scoliosis, the primary right curve extending from the sixth thoracic to the second lumbar vertebra, with the apex at the tenth thoracic vertebra. She had had jacket correction and spine fusion two years before coming to this Clinic, the fusion having been done from the fifth thoracic vertebra down to and including the eleventh thoracic, but omitting the lower three vertebrae of the primary curve. Figure 1 shows clearly that there had been an increase or recurrence of the deformity at these three joints—eleventh thoracic to second lumbar—and that as the result of this the trunk was shifted to the right side. Fusion appeared solid from the fifth to the eleventh thoracic vertebra.

A pelvic-tilt examination was made, the patient sitting unassisted with the left side of the pelvis elevated. (See Figure 2.) This demonstrates the flexibility and muscle power at the lower lumbar joints and shows the extent to which the compensatory curve in this area might be expected to straighten under its own muscle power after correction and fusion of the primary curve above. In this instance only slight correction of the low lumbar compensatory curve is obtainable.

After the desired correction of the primary curve (in this case the maximum obtainable) had been achieved in the wedging jacket, a roentgenogram was taken with a skin marker on the spine of the first lumbar vertebra (Fig. 3). This film was studied to determine the exact extent to which fusion should be done. The final total alignment of the trunk after extension of the fusion into the lumbar area depends upon the alignment within the fusion area and the power of the unfused lower lumbar spine to bring this fusion area into the erect compensated alignment. The balance between these two areas may be visualized by superimposing the proposed fusion area, as shown in the immediately preoperative marker roentgenogram, upon the lower area, as shown in the pelvic-tilt roentgenogram.

In the present instance, allowing for the usual slight loss of correction during the first year after fusion, it will be seen that the lower surface of the third lumbar vertebra (dotted line, Fig. 3) will be very nearly transverse to the axis of the corresponding segment of the trunk. It should sit squarely upon the upper surface of the fourth lumbar vertebra, which, in the pelvic-tilt examination, is seen to be nearly transverse to the body axis (dotted line, Fig. 2). The total alignment of such a combination is good (Fig. 4). Therefore, in April 1934, fusion was extended downward to include the third lumbar vertebra, one vertebra beyond the primary curve.

Figure 4, taken three years after operation, shows the total alignment to be good. All correction has been maintained at each joint except for slight loss between the eleventh and twelfth thoracic vertebrae, and the fusion is solid from the fifth thoracic to the third lumbar vertebra. The result is that which should be visualized on superimposing or setting

Cord Injury and Vertebral-Column Fracture.
Dr. William A. Rogers, Boston, Massachusetts.
Crush Fractures of the Spine.
Dr. John Dunlop, Pasadena, California.
Crush Fractures of the Spine.
Mr. R. Watson Jones, Liverpool, England.
The Treatment of Paralytic Bladder in Cases of Cord Injury.
Dr. Frank Hinman, San Francisco, California.
Rupture of the Intervertebral Disc as the Cause of Low-Back Pain with Unilateral Sciatic Radiation.
Dr. J. M. Robinson, San Francisco, California.
Tensile Strength of the Anterior Common Ligament.
Dr. A. G. Davis, Erie, Pennsylvania.

*Afternoon Session*

The First Stages of Coxa Plana.
Dr. Henning Waldenström, Stockholm, Sweden.
Manipulative Surgery.
Dr. Philip Lewin, Chicago, Illinois.
Manipulative Method of Treatment of Backache.
Dr. F. A. Jostes, St. Louis, Missouri.
Some Problems of Bone Growth.
Dr. J. B. deC. M. Saunders, San Francisco, California. (By invitation.)
Dr. V. T. Inman, San Francisco, California. (By invitation.)
Posterior Hernia of the Knee Joint (Baker's Cyst), a Cause of Internal Derangement of the Joint.
Dr. G. E. Haggart, Boston, Massachusetts.

THURSDAY, JANUARY 20

*Morning Session*

Avulsion Fractures of the Greater Trochanter of the Femur.
Dr. Henry Milch, New York, N. Y.
Opposition of the Thumb.
Dr. Sterling Bunnell, San Francisco, California. (By invitation.)
The Healing of Joint Fractures: A Clinical and Experimental Study.
Dr. K. O. Haldeman, San Francisco, California.
Healing of Fractures of Atrophic Bones: A Clinical and Experimental Study.
Dr. E. L. Compere, Chicago, Illinois.
Bone Block for Painful Hips.
Dr. J. B. L'Episcopo, Brooklyn, New York.

*Executive Session*—12:00 Noon

*Afternoon Session*

Results of Treatment of Slipping of the Upper Femoral Epiphysis by Nailing.
Dr. Philip D. Wilson, New York, N. Y.
The Operative Lengthening of the Tibia and Fibula: A Further Development in Principles and Technique.
Dr. L. C. Abbott, San Francisco, California.
Dr. J. B. deC. M. Saunders, San Francisco, California. (By invitation.)
Roentgen-Ray Evidence of Metastatic Malignancy in Bone.
Dr. Henry Snure, Los Angeles, California. (By invitation.)
Experience with Bone Tumors at the Boston City Hospital from 1932 to 1936.
Dr. R. F. Sullivan, Boston, Massachusetts.
Treatment of Fibrocystic Cavities in Bone by Curettage and Packing with Bone Chips.
Dr. W. E. Swift, New York, N. Y.
Dr. Halford Hallock, New York, N. Y.

# News Notes

The Sixth Annual Convention of the **American Academy of Orthopaedic Surgeons** will be held in Los Angeles, California, January 16 to 20, 1938, under the presidency of Dr. A. Bruce Gill. The headquarters will be at the Biltmore Hotel and the following program has been arranged:

TUESDAY, JANUARY 18

*Morning Session*

Sacro-Iliac Fusion: A Modification of the Smith-Petersen Technique.
Dr. A. F. O'Donoghue, Sioux City, Iowa.

Two-Stage Extra-Articular Knee-Joint Fusion for Tuberculosis.
Dr. Don King, San Francisco, California.

Treatment of Extreme Flexion Contracture at the Knee Joint.
Dr. S. L. Haas, San Francisco, California.

A Procedure for the Correction of Internal-Rotation Contractures of the Thigh in Spastic Paralysis.
Dr. H. A. Durham, Shreveport, Louisiana.

The Evaluation of Surgical Procedures on Bones, Muscles, and Peripheral Nerves in Spastic Paralysis.
Dr. L. C. Wagner, New York, N. Y.
Dr. Francis J. Carr, New York, N. Y.
Dr. Arthur Thibodeau, New York, N. Y.

*Executive Session*—12:00 Noon

*Afternoon Session*

President's Address.
Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Non-Union and Bone-Graft Symposium—Dr. N. T. Kirk, San Francisco, *Chairman:*

Massive Onlay Graft in Ununited Fractures of the Long Bones, with Report of End Results.
Dr. Willis C. Campbell, Memphis, Tennessee.

Bone Grafts in Ununited Fractures.
Dr. M. S. Henderson, Rochester, Minnesota.

Inlay Grafts and Intramedullary Pegs in Ununited Fractures.
Dr. Edwin B. Ryerson, Chicago, Illinois.

Treatment of Non-Union of Fractures with Particular Reference to the Humerus.
Dr. G. E. Bennett, Baltimore, Maryland.

Transplantation of the Fibula in the Leg: (a) For Large Defect in the Tibia; (b) Transfer of Upper End to Restore Ankle Mortise.
Dr. W. B. Carrell, Dallas, Texas.

WEDNESDAY, JANUARY 19

*Morning Session*

Symposium on Fractures of the Spine—Dr. A. G. Davis, Erie, *Chairman:*

First Aid and Transportation of Suspected Spine Injuries.
Dr. J. E. M. Thomson, Lincoln, Nebraska.

Indications for Operation in Cord and the Caudal Injuries.
Dr. Howard C. Naffziger, San Francisco, California.

Evaluation and Treatment of Acute Cervical-Spine Injuries.
Dr. W. Gayle Crutchfield, Richmond, Virginia.

The Twelfth Congress of the **Deutsche Gesellschaft für Unfallheilkunde, Versicherungs- und Versorgungsmedizin** was held in Würzburg on September 24 and 25, 1937, under the presidency of Prof. Dr. Reichardt, the distinguished alienist.

The very full and interesting program, although devoted chiefly to psychological and neurological subjects, included the following communications of orthopaedic interest:

Dr. Vogler, of Stettin, reported on lumbar puncture in head injuries, with especial reference to American practices. He demonstrated the good results of this method by a large amount of statistical material.

Dr. Demme, of Hamburg, discussed nerve injuries caused by intramuscular injection. His experiments on animals proved that India ink injected into the nerves of the leg penetrated the nerve roots.

Dr. Wanke, of Kiel, described his investigations on the lumbago and scalenus-muscle syndrome.

Of especial interest was the discussion by Dr. vom Stracke, of Erlangen, on the so-called traumatic neurosis.

The next Congress will be held in Giessen in 1939 under the presidency of Prof. Dr. A. W. Fischer.

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The Nineteenth Congress of the **Société Française d'Orthopédie et de Traumatologie** was held in Paris on October 7, 8, and 9, 1937, under the presidency of Prof. Etienne Sorrel.

The "Orthopaedic Days", October 7 and 8, were spent in visiting the Services of Prof. Ombredanne, Dr. Mathieu, Prof. Sorrel, Dr. Leveuf, and Dr. Boppe, where operations were demonstrated and patients were presented.

Prof. Sorrel opened the Congress with a paper on the growth of orthopaedics in France and its present tendency to become more and more surgical. He expressed the hope that France would soon follow in the wake of other countries and establish services devoted exclusively to orthopaedic surgery.

The two main subjects considered by the Congress were as follows:

*The Transplantation of Tendons in the Treatment of Club-Foot*—Dr. Jacques Leveuf, of Paris, and Dr. A. D. Perrot, of Geneva.

The first part of the discussion was confined to three topics:

1. The conditions necessary for a successful transplantation:
   a. Integrity of the muscle itself.
   b. Integrity of the structures used for the protection of the tendon.
   c. Fixation of the tendon.
   d. Tension on the transplanted muscle.
   e. Postoperative care.
2. Functional adaptation of the transplanted muscles.
3. Reestablishment of the muscular equilibrium.

The second portion of the report dealt with the special indications for transplantation of tendons in the following conditions: (1) paralysis of the triceps surae; (2) paralysis of the tibialis anterior; (3) paralysis of the supinators; (4) paralysis of the pronators. The use of this procedure in pes equinus and pes cavus was also discussed, although these affections are not the direct result of paralysis.

*Bilateral Coxalgia*—Dr. Louis Allard, of Berck.

After having given the clinical description of bilateral coxalgia and its prognosis, Dr. Allard confined himself to the treatment of this affection. He concluded that the treatment should first strive for anatomical cure of the focus in good position. After this has been obtained, one should use the utmost care to prevent sequelae. Each case has its own indications. Among the procedures to be considered are those simple operations without danger,—namely, osteotomy for correction and arthrodesis in certain cases. Operations for mobilization should be seriously debated and should not be advised without warning the patient of possible failure. Dr. Allard favored the plastic

Dr. Frank R. Ober, Assistant Dean of the Harvard Medical School, has been made Professor of Orthopaedic Surgery at the University of Vermont.

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Prof. Etienne Sorrel, of Paris, announces the removal of his office to 123, rue de Lille.

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Dr. William J. Stewart announces the opening of an office at 401 Guitar Building, Columbia, Missouri.

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The Seventh Walter M. Brickner Lecture was given at the **Hospital for Joint Diseases** on Thursday evening, November 18, 1937, by Dr. Sterling Bunnell of San Francisco. The subject of the lecture was "Reconstructive Surgery of the Injured Hand".

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A joint meeting of the **Deutsche Gesellschaft für Chirurgie** and the **Deutsche orthopädische Gesellschaft** will be held in Berlin on April 21, 1938, at the Langenbeck-Virchow-Haus. The special subject for discussion will be "Traffic Accidents".

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The Third Annual Meeting of the **Orthopaedic Guild** was held on November 26 and 27 in Richmond, Virginia, with Dr. T. F. Wheeldon as Chairman. The next Meeting will be held in Toronto on November 25 and 26, 1938, under the Chairmanship of Dr. A. W. Farmer.

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The **Polish Society of Bone and Joint Surgery and Traumatology** will hold its next meeting in Poznan on April 2 and 3, 1938. The discussion at this meeting will be confined to two subjects: "Infantile Paralysis", by Prof. Raszeja; and "Interarticular Fractures", by Prof. Gruca.

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The Sixty-Seventh Annual Meeting of the **American Public Health Association** will be held in Kansas City, Missouri, on October 25 to 28, 1938. Dr. Edwin Henry Schorer, Director of the Kansas City Health Department, has been appointed Chairman of the Local Committee. He will be assisted by a large group of city and state officials and community leaders.

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The **Clinical Orthopaedic Society** met in Chicago on October 14, 15, and 16, to celebrate its Silver Anniversary and to honor Dr. John Lincoln Porter, its first President.

Most interesting and instructive clinics were presented at Cook County Hospital, the Research and Educational Hospitals of the University of Illinois, St. Luke's Hospital, Albert Merritt Billings Hospital, and Northwestern University Medical School.

The meeting was climaxed by the annual banquet held on Friday, October 15, at the Palmer House. The banquet was under the direction of Dr. J. E. M. Thomson, President of the Society, and Dr. Albert H. Freiberg, Toastmaster. A gold medal with the inscription "To Dr. John Lincoln Porter, The Founder of The Clinical Orthopaedic Society" was presented to the guest of honor by Dr. A. Bruce Gill. A short acceptance address was made by Dr. Porter in his usual sincere and modest style. Bronze medals of Dr. Porter, made from a wood carving by Dr. J. E. M. Thomson, were presented to the members. The John Lincoln Porter Lecture was given by Dr. Willis C. Campbell, who spoke on the subject of "Malunited Fractures". Additional remarks were made by Dr. Samuel Kleinberg, Dr. E. W. Ryerson, Dr. Melvin S. Henderson, Dr. Arthur Steindler, and Dr. Philip Lewin.

The next meeting will be held in Nashville and Birmingham during the Fall of 1938.

siderable shortening (in this operation the anteversion is adjusted at the same time); (3) detorsion operation by an oblique intertrochanteric osteotomy, used with the shelf operation in cases of subluxation combined with anteversion and valgosity of the neck. He reported satisfactory results in adolescents and in adults, but emphasized the need of operation where possible in early childhood—between the ages of three and six years—as the results are better than at a later age.

Prof. Spišić showed a film demonstrating the non-operative treatment and emphasized the need for instruction of the general public so that congenital dislocation could be treated at as early an age as possible. In his treatment he used also Putti's and Hilgenreiner's splints.

Prof. Rocher discussed the end results obtained by the non-operative treatment. Examination ten or more years after replacement showed subluxation and deformation of the head in most of the cases. He believes that every dislocation should be kept under x-ray control until adolescence.

Prof. Frejka emphasized the need of training the medical profession to treat dislocations as early as possible,—at the age of one and one-half years at the latest. The teaching that results will be equally successful after the second year encourages delay in reposition. He demonstrated the good results obtained by detorsion operations in which he used Zahradníček's method, which he prefers to the simpler shelving operation without reposition and without adjustment of anteversion. He showed several cases of operative replacement by the Zahradníček method.

Dr. Pavlanský discussed the necrosis of the head which occurs in the course of non-operative treatment, and showed that this is frequent after non-operative replacements, particularly when the luxation is high. After operative replacement and detorsion osteotomy, he had not observed necrosis of the head. In Prof. Zahradníček's Clinic, cases are treated non-operatively up to the age of three or three and one-half, and, after the third year, by operation. Necrosis of the head is thought to be the result of ischaemia arising from strain of the capsule at the time of the reduction.

There was also discussion by Prof. Mikula, Dr. Janek and Dr. Mestrić, Dr. Alberti, Dr. Delić, Dr. Vlašić, and Dr. Ambrožić, who gave their experiences with the treatment of this disorder.

The second main subject dealt with was "War Injuries of Bones and Joints". Dr. Florschüts spoke of methods of treatment, and Dr. Danić placed the blame for the bad results during the War on the organization of the work, and emphasized the necessity of these cases being in charge of and treated by men of experience.

Papers were presented by Prof. Zahradníček on his operation for spondylolisthesis and by Prof. Frejka on infantile kyphosis. Prof. Spišić showed a film on the treatment of contractures of articulations by plaster bandages and the Quengel method. Dr. Janěk spoke of the significance of the gonococcus reaction in articular diseases. Dr. Jovćić demonstrated the results of reductions of traumatic dislocation of the hip. Dr. Grospić showed slides to illustrate the results of plastic operations on the knee, the hip, and the elbow. Dr. Delić spoke on spine grafting, and stated that in the most severe cases of thoracic gibbosity he uses a solid bone graft introduced above or below the gibbosity by transversectomy. Dr. Stojadinović demonstrated the results of treatment of cysts of the bone. Dr. Savić showed slides to illustrate the results of operative replacement of old dislocations of the shoulder and the elbow.

The Congress closed with a reception at the Belgrade Aero-Club. The next Congress will take place in Prague early in July 1938, at the same time as the Pan-Slavonic Medical Congress and the Pan-Sokol Raily. The principal subjects will be "Pseudarthrosis", to be discussed by Prof. Zahradníček, and "Necrosis of Bone", by Dr. Frejka.

## BRITISH ORTHOPAEDIC ASSOCIATION

The Annual Meeting of the British Orthopaedic Association was held in Sheffield on October 29 and 30 under the Presidency of Mr. W. R. Bristow. A large number of

intertrochanteric osteotomy which preserves intact the musculature and leaves the abductors attached to the trochanter.

The remainder of the Congress was devoted to the presentation of the following papers:

Vertebral Aspects of Paget's Disease—Dr. Charles Lasserre, of Bordeaux.
Blood Chemistry in Various Diseases of Bone—Dr. Charles Lasserre and Dr. L. Servantie, of Bordeaux.
Slipping of the Patella—Dr. Guilleminet and Dr. Brunat, of Lyons.
Correction of Scoliosis by Plaster Cast—Dr. Lucien Michel, of Lyons.
Chondrodystrophy with Widening and Flattening of the Vertebrae (Platybrachyspondylia)—Dr. R. Guérin and Dr. P. Lachapèle, of Bordeaux.
Congenital Luxation of the Atlas through Malformation of the Axis—Dr. Lombard and Dr. Le Génissel, of Algiers.
Infantile Kyphosis—Prof. Frejka, of Brno.
Fractures of the Upper End of the Radius, with a Report of Seventeen Cases—Dr. H. L. Rocher, of Bordeaux.
Arthroereisis with "Os Purum"—Dr. P. Marique, of Brussels.
Drilling of the Neck of the Femur in Arthritis Deformans of the Hip—Dr. R. Charry and Dr. G. Charry, of Toulouse.
Roentgenography of the Articulations—Dr. F. Pouzet, of Lyons.
Tibia Vara—Dr. Pouzet, of Lyons.
Astragalectomy—Dr. Petrov, of Sofia.
Congenital Deformities—Dr. Nicod, of Lausanne.
Deformities of the Menisci of the Knee—Dr. Dieterich, of Mulhouse.

The next Congress will be held in Paris on October 7, 1938, at the *Faculté de Médecine de Paris*, under the presidency of Prof. H. L. Rocher, of Bordeaux. The subjects to be discussed are: "Painful Vertebral Kyphosis Due to Dystrophy" and "Simultaneous Fractures of the Shafts of Both Bones of the Forearm".

The Society will visit the orthopaedic centers of the important cities of Switzerland at the end of September 1938.

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The Congress of the **Yugoslavian** and **Czechoslovakian Orthopaedic Societies** was held in Belgrade, on October 18 and 19, 1937. Prof. Dr. Rocher of Bordeaux, Prof. Dr. Gruca of Lwow, Poland, Prof. Dr. Raszeja of Poznan, Poland, and Prof. Dr. Boićev of Bulgaria, were present as guests, and there were representatives from all the Slavic countries except Russia. The principal subject of discussion was "Congenital Dislocation of the Hip".

Docent Dr. Jovćić called attention to the prevalence of congenital dislocation of the hip in Yugoslavia and estimated that there were about 30,000 cases in his country. He reported that, in a total of 900 cases which he had treated, the best results had been obtained in patients under two years of age, both anatomical and functional results at this period being 100 per cent. successful. Correct replacement and treatment by the use of plaster bandages require real skill and should only be attempted by those who are highly experienced.

The second speaker, Prof. Zahradníček, presented the operative treatment of this luxation. He regards subtrochanteric osteotomy of the Kirmisson-Lorenz-Schanz type as an erroneous procedure, which should be used only when the anatomical changes are of too pronounced a character or when the patient will not agree to a radical operation. The radical operations performed in Prof. Zahradníček's clinic are of three types: (1) operative replacement without shortening of the femoral bone, either with or without the shelf operation (this method is suitable mainly for small children in whom not much shortening takes place and the soft parts, notably the articular capsule, present an anatomical obstacle to replacement); (2) operative replacement and shortening of the femoral bone, with the shelf operation, which is necessary in luxations with con-

*Some Principles of Joint Mechanics* by Mr. M. A. McConaill, Sheffield

In a most stimulating résumé, Mr. McConaill presented his views on joint mechanics derived from six years of anatomical investigation. He maintained that the chief function of the specific synovial fluid is to prevent friction,—a function which is least active during the full coaptation of the joint surfaces in weight-bearing. Hence degenerative changes occur most frequently on those surfaces which fit together best. The ligaments are not elastic and are so arranged that they act to prevent the harmful effects of torsion. Mr. McConaill's thesis was new to many members of the Association and it evoked much enthusiastic interest. It is to be hoped that his work will be available in written form later.

*Some End Results of Bone and Joint Tuberculosis* by Mr. J. C. Scott, Oxford

Mr. Scott presented a preliminary report of an end-result survey of 582 patients suffering from tuberculous disease of the spine and of the hip joint. As far as possible the results of conservative treatment alone were contrasted with those in which conservative treatment had been reenforced by operative measures. The combined procedure appeared to have a slight advantage.

*Certain Injuries of the Carpus* by Mr. J. L. Grout, Sheffield

Mr. Grout reported his findings in an x-ray investigation of the wrists and hands of some thirty-nine workers who use pneumatic drills and chisels. In a little less than half of the men, small cystlike spaces, giving rise to no symptoms, were found in the carpal and metacarpal bones. No explanation of these cysts is available at present. Osteo-arthritis of various joints was a common finding.

*The Early Diagnosis of Malignancy in Bone Tumors* by Dr. J. F. Brailsford, Birmingham

Dr. Brailsford gave for the most part an excellent résumé of the present-day attitude in relation to the diagnosis and treatment of malignant bone tumors. He emphasized the difficulties in diagnosis in general, and of x-ray interpretation in particular. In doubtful cases he prefers to be guided by serial roentgenograms, and he differs substantially from his surgical colleagues in condemning the routine use of biopsy. If the latter *is* used, the area selected for the removal of tissue should be determined with precision beforehand by the roentgenologist. Dr. Brailsford made a strong plea for closer cooperation between the clinician, the pathologist, and the roentgenologist.

*Nephrolithiasis Occurring in Recumbency* by Mr. R. Guy Pulvertaft, Grimsby

The cases of sixty patients, who, during long periods of immobilization in recumbency for tuberculous bone or joint lesions, had developed renal calculi, were reviewed. The factors responsible for stone formation appear to be defective renal drainage and the wide-spread skeletal and muscular decalcification. Preventive measures consist of frequent "turnings" of the patient, avoidance of excessive exposure to the sun, and a generous fluid intake. A minority of stones require operative removal. The majority are passed as "gravel" when "turnings" are commenced or when the patient becomes ambulatory.

*Arthrodesis of the Hip* by Mr. R. Watson Jones, Liverpool

The technique of intra-articular arthrodesis, followed some ten days later by the "closed" introduction of a long Smith-Petersen nail along the femoral neck deeply into the ilium, was described. It was claimed that the combined procedure had greatly increased the chances of securing bony union. The excellent results achieved were demonstrated in a very instructive film. Mr. Watson Jones referred briefly to the method, still on trial, of fixing the osteo-arthritic hip by a long Smith-Petersen nail introduced through a short incision without a preliminary denudation of the articular surfaces. This procedure obviously is more applicable to older people than is the combined operation, and the results so far have been encouraging.

members and guests were present and enjoyed a most stimulating program. The Association Dinner was held at the Royal Victoria Hotel. The guests included the Chairman of the Royal Infirmary and the Vice-Chairman of the Children's Hospital, as well as many distinguished members of the University and Hospital Medical Staffs. Prior to the dinner, visits to one of the large steel works and to a coal mine had been most interesting interludes in the scientific proceedings.

The scientific program was divided into two parts, as follows:

I. A Clinical Demonstration which was given in the Out-Patient Department of the Sheffield Royal Infirmary. Many patients illustrating the results of treatment of fractures and of diseases and neoplasms of the locomotor system were shown by Mr. S. W. Daw, of Leeds, and Mr. J. B. Ferguson Wilson, Mr. C. Lee-Pattison, Mr. Arthur M. Connell, and Mr. F. W. Holdsworth, all of Sheffield.

II. The Presidential Address and a series of short papers which occupied two mornings at the Medical Library of the University.

*Orthopaedic Surgery—Retrospect and Forecast* by Mr. W. R. Bristow, London

The President traced the post-war growth in Orthopaedic Surgery which had proceeded *pari passu* with specialization in other surgical fields. Decentralization was increasing, especially in orthopaedic surgery, and was causing the university hospitals some difficulty in obtaining representative clinical material for the purposes of student teaching. It was suggested that this difficulty might be overcome by closer cooperation between city and country hospitals. The President also outlined the changes which would have to take place, as a result of multiple special departments, in the curriculum of the student during his hospital training so that he could have practical experience in each branch of Surgery.

*Treatment of Minor Injuries* by Mr. W. G. Campbell, Dundee

A detailed account was given of the early treatment of strains of ligaments and muscles by the injection of a local anaesthetic into the site of tenderness. It was assumed that Leriche's conception of strain is the right one,—namely, that there is no tearing of ligamentous fibers, but apparent impulses passing from the "damaged" area begin a vicious circle of local vasodilatation, metabolites, etc. In a comparative series of patients Mr. Campbell found that treatment by this method had resulted in cure in about three days, as compared with twelve days by the conventional method of strapping, etc.

*The Correction of Spinal Kyphosis by Means of a Continuously Adjustable Bed* by Mr. R. W. Butler, Cambridge

With diagrams and a model, Mr. Butler demonstrated in detail how to make and to use his ingenious sectional plaster-of-Paris bed for the correction of anteroposterior deformities of the spine.

*Ossification of Ligaments of the Elbow Joint* by Mr. St. J. D. Buxton, London

The frequency of ossification in the ligaments following injuries, especially dislocations, was stressed. It was emphasized that the amount of ossification is governed largely by the treatment of the injured joint. If rested for an adequate period (several weeks), no harmful amount of ossification results, but if efforts are made early to force movements, then extensive new bone formation often occurs and the mobility of the joint is seriously restricted for all time.

*Undulant-Fever Osteitis* by Prof. Green, Sheffield

A most interesting review of the literature on this rare fever was presented and various features of it demonstrated from the records of a patient under Prof. Green's care. Bones and joints are frequently involved and abscesses form which usually resolve quickly without persistent sinuses. The roentgenographic changes in the bony lesions are not typical and may resemble those seen in tuberculous disease. Ankylosis of joints is rare and the general prognosis is good.

up the third lumbar vertebra in the marker roentgenogram (Fig. 3) on the fourth in the pelvic-tilt examination (Fig. 2). The patient is normally active and has no symptoms referable to the spine. Her shoulders are level, and the head and trunk are well centered over the pelvis.

*Case 2 (Figures 5, 6, 7, and 8)*

L. C. T., female, aged fourteen years, had an "idiopathic" scoliosis, the primary right curve extending from the fifth thoracic to the first lumbar vertebra with the apex at the ninth thoracic. She had had jacket correction and spine fusion three and a half years before admission to this Clinic. Figure 5 shows that the fusion area did not include the whole of the primary curve, but stopped below at the eleventh thoracic, and that pseudarthroses were present at four joints in the area operated upon,—the fourth thoracic to the eleventh thoracic. The deformity obviously had increased or recurred within the area operated upon and at the joints within the primary curve which had been omitted,—the eleventh thoracic to the first lumbar.

A pelvic-tilt examination was made, the patient sitting with the left side of the pelvis elevated (Fig. 6). This showed excellent straightening at each of the joints in the lumbar spine, and justified the expectation that the same thing would occur in proper degree after correction and fusion of the primary thoracic curve.

After jacket correction was obtained, the spine-marker roentgenogram (Fig. 7) was made. This shows the position in which the spine is to be fused. To fuse the minimum area—the extent of the primary curve (the fifth thoracic to the first lumbar)—might give a satisfactory result, but to extend the fusion one vertebra above (to the fourth thoracic) and one vertebra below (to the second lumbar) would give a more nearly ideal result, because the end vertebrae of the fusion would be parallel to each other and transverse to the axis of the trunk. One may choose to extend the minimum fusion to form this ideal area provided that the unfused portions of the spine above and below, and particularly below, are capable of complete spontaneous straightening under their own muscle power. Allowing for slight loss during the first year after fusion, it will be seen in the present case that the lower surface of the second lumbar vertebra (dotted line, Fig. 7) will be transverse to the body axis and should sit squarely upon the upper surface of the third lumbar when the latter has straightened to the position shown in the pelvic-tilt examination (dotted line, Fig. 6). A superimposition of the third lumbar in the marker roentgenogram on the fourth lumbar in the pelvic-tilt examination will obviously not give a good total alignment. In December 1932, the previous fusion was extended to include the second lumbar vertebra and the four pseudarthroses were found and repaired, making the total fusion area from the fourth thoracic to the second lumbar vertebra.

Figure 8, taken three and a half years later, shows the fusion to be solid throughout and the total alignment to be excellent. Considerable

# Current Literature

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS. John Albert Key, B.S., M.D., and H. Earle Conwell, M.D., F.A.C.S. Ed. 2. St. Louis, The C. V. Mosby Co., 1937. $12.50.

This new edition is larger and more attractive than the first. Again the authors have produced a book which is a good working guide for the surgeon, practitioner, or student. The same arrangement as in the first edition—Part I: Principles and General Aspects; and Part II: The Diagnosis and Treatment of Specific Injuries—is retained. Many chapters have been slightly altered; there are some new illustrations, and, in certain places, better illustrations have been substituted.

As in the previous edition, there are excellent and unusual chapters dealing with the Workmen's Compensation Law as it affects fracture cases and the medicolegal aspects of fracture cases.

The chapters on "Fractures of the Skull and Brain Trauma" by C. E. Dowman and "Fractures of the Jaws and Related Bones of the Face" by J. B. Brown have been rewritten. The alterations in the latter chapter are the most radical in the book. The illustrations in this chapter are numerous and excellent and the text shows evidence of a great deal of careful study.

Injuries of the spine are discussed from the point of view of today's treatment. Much has been added in regard to the treatment of compression fractures. A discussion of rupture and herniation of the intervertebral discs, a subject of much interest and concern at the present time, has been included for the first time. However, fourteen lines with no illustrations seems like an inadequate presentation of such an important subject in a chapter of ninety-four pages on spine injuries.

This book is very interesting. The experiences of the authors seem to dovetail very nicely. Wherever there is a difference of opinion or in technique, both opinions are given. This second edition contains no revolutionary changes, but represents a modernization of the previous volume.

TABLE GÉNÉRALE DES ANNÉES 1908–1932 DU JOURNAL DE CHIRURGIE. Établie par J. Dumont et P. Grisel, avec la collaboration de M^me^ J. Dumont. Paris, Masson et C^ie^, 1937. 260 francs.

This book is an index of the original papers and articles abstracted in the first forty volumes of *Le Journal de Chirurgie*. This material has not been classified according to the usual alphabetical order, but according to the subject matter, as is the custom in the monthly issues of this publication. The references are first arranged under general headings such as "Surgical Pathology", "Skin", "Cartilage", "Bone", "Muscles", etc., and subdivided, and then they are grouped under regions with their structures. In this way is made easily available all of the material which has been published in these forty volumes with reference to a particular subject. The references are arranged chronologically according to the volume in which they appeared.

As an added convenience, the editors have placed at the beginning of the volume an index of the original articles arranged alphabetically according to the authors.

As is explained by Dr. Grisel in the Foreword, the index covers the abstracts from April 1, 1908, to December 1, 1932, but it includes the original articles up to December 1935.

This book should be a valuable addition to the physician's reference library.

THE THINKING BODY. A STUDY OF THE BALANCING FORCES OF DYNAMIC MAN. Mabel Elsworth Todd. New York, Paul B. Hoeber, Inc., 1937. $4.00.

After many years of practical experience and special study combined with laboratory investigation, Miss Todd has presented her original views on this general subject

of physiotherapy. This work is considered through quite a new approach, and the author carefully avoids any claim to a school or system but aims to present, more or less originally, the principles involved in utilizing the coordination of the related functions of the body. As its title indicates, the book is not a treatise dealing with the conventional acceptation of the subject of physiotherapy, but represents the result of an individual study and investigation of the physical and psychological influences which underlie body development.

From the beginning of her work on this particular form of therapy, the author emphasizes the value of the coordinating movements and the necessity of understanding and cooperation on the part of the patient. One of the principal objects of the book is to aid those who are engaged in the practice of physiotherapy to obtain body balance in such a way that it may be a factor in daily life and correct the ill effects which result from body imbalance. The author wisely emphasizes the influences which are attributable to psychology and gives to them more prominence than is usually found in textbooks dealing with this subject. She emphasizes the necessity of a thorough understanding of anatomy, physiology, and nerve control in order to appreciate the important part which they play in the movements of the body. This forms the basis on which her theories are founded and put into execution.

The special functions, such as breathing, walking, etc., are analyzed in detail. Posture, both normal and defective, is given adequate consideration, and the discussion of the principles of correction of posture defects and the methods of accomplishing this correction will be found to contain much that is original. The skeletal and muscular systems and their combined action in the development and maintenance of the normal body balance are given special prominence, with a very full discussion of the fundamental rôle which they play, as well as the importance of their coordination.

In this unique presentation, the reader will find much to interest and to aid him in the performance of his daily work, even though he may not always agree with all of the theories and practices.

PHYSICAL THERAPY IN ARTHRITIS. Frank Hammond Krusen, M.D. Foreword by Melvin S. Henderson, M.D. New York, Paul B. Hoeber, Inc., 1937. $2.25.

Arthritis has been termed the "stepchild" of Medicine, but there can be no stepchild without a step-parent. The author has commendably applied himself to the preparation of this little book, primarily as a guide for the general practitioner. This appears to have been done with a realization of the fact that insufficient familiarity with the possibilities of physical therapy and with its technique are largely responsible for the defeatist attitude often assumed by the physician. Having disposed of foci of infection as well as may be and having employed various drugs and sera, he finds that arthritis still remains to be treated. In this situation, he is only too often found uninformed regarding the applicability of the various methods to the case in question, or under the mistaken impression that they are available only through institutional care.

To the author's credit it must be said that he has successfully striven to give a more correct conception of the situation to the reader. His descriptions are clear and well suited to the compendious form which he has chosen. Perhaps it may be said that, in his desire to give credit to those who have contributed to the literature of the subject, his text abounds in a superfluity of quotations which does not add to its clarity, especially since the complete references are also given. While the various methods in use are sufficiently described, there is an admirable lack of excessive emphasis upon the need for those whose value is not generally accepted. It must be admitted, however, that in a number of instances methods and apparatus are portrayed whose employment would be precluded in any but the more commodious homes or well-equipped institutions. This but emphasizes the fact that, while those arthritics who have abundant means may and do engage in the elusive search of a climate which will cure them and the services of well-staffed institutions, there is a general and unfortunate paucity of provision for

sufficiently extended care of those in less fortunate economic situations. It would seem difficult to agree, without considerable qualification, with the author's final sentence:

"With a little ingenuity the family physician can supply nearly all the necessary physical therapy in the patient's own home."

BEITRAG ZUR KENNTNIS DER ANGEBORENEN HÜFTGELENKSVERRENKUNG (A Contribution to Our Knowledge of Congenital Dislocation of the Hip). Dr. Max René Francillon. (Beilageheft zur Zeitschrift für Orthopädie, Bd. LXVI.) Stuttgart, Ferdinand Enke, 1937. 9.80 marks.

One hundred and ninety-six cases of congenital dislocation of the hip were reviewed primarily in the interest of "ischiometric" determinations. In the course of the follow-up examinations, a critical study of the end results furnished interesting data. These, with comparative studies from other sources, have been expanded to form a comprehensive monograph.

The ratio of eight females to one male, instead of the usual six to one, is explained on anthropological grounds. The accurate diagnosis and prognosis in the luxated hip, and particularly in the subluxated hip, entail careful study of the development and position of the osseous center of the head, of Shenton's (better Menard's) line, and of the degree of ossification of the ischiopubic synchondrosis. Both the developmental and the mechanical factors in the causation are variables.

Retarded development is evident in the delayed ossification of the ischiopubic synchondrosis, the os acetabuli superior, and the osseous center of the femoral head; as well as the persistent anterior torsion of the femur. The retroversion and shape of the femoral head are discussed. An extensive review of the frequent osteochondral lesion of the head leads to the conclusion that it is a peculiar reaction of the bone (probably with several exciting causes) and not a specific disease.

"Ischiometric" determinations as suggested by Scherb are recorded in three cases to illustrate how this clinical-mathematical observation supplements the roentgenographic findings in determining the shape of the femoral head and the condition of the joint cartilage.

Detailed anatomical studies are well illustrated.

TISSUE REACTIONS IN BONE AND DENTINE. A MORPHO-BIOLOGICAL STUDY OF THE FORMATION AND THE DISSOLVING OF BONE AND DENTINE. Åke Wilton, M.D. London, Henry Kimpton, 1937.

This 194-page book reflects a great deal of meticulous work and serious thought on the subject of determination and differentiation in bone and dentine. The presentation is clear and scholarly. There are many good illustrations, of which several are in color. A comprehensive bibliography is appended.

The author's own investigations, consisting of nine years of careful histological study of the normal and the pathological development of bone and dentine, are recounted after a complete review of the literature. The author has introduced to the subject what he terms an "N-factor", which brings about abnormally slow differentiation and decrease in growth, acting generally on the tissues of the connective system, and most strongly where the rate of growth is greatest. The skeletal deformities in rickets and achondroplasia are thought to be caused by the action of this N-factor on the normal endochondral ossification. By comparative studies of the arrest of development of cartilage, bone, and teeth in achondroplasia, the N-factor is shown to act during foetal life in inverse proportion to the degree of determination and differentiation of the tissues.

The author has made a study of osteolysis in experimental osteitis fibrosa cystica, scurvy, Paget's disease, osteogenesis imperfecta, senile osteoporosis, and the dissolution of transplanted bone grafts. The author has found that vitamin-C deficiency produces an abnormal dedifferentiation with abnormal proliferation of the dentine and bone,

and considers the scorbutic dentine alterations in guinea-pigs clear proof that a tissue may grow—that is, increase its number of functioning tissue elements—by dedifferentiation of previously differentiated cells. During healing, redifferentiation takes place. In Paget's disease it is shown that osteolytic foci arise by dedifferentiation of differentiated bone cells (osteocytes). Giant cells and a granulation-like tissue (Virchow's tissue) then arise to proliferate into the atrophic periosteum. On redifferentiation, bone formation occurs outside the original compact, and, by repetition of the process, increase in breadth takes place. In osteogenesis imperfecta, osteolysis occurs as in scurvy, in the main, and alterations are most pronounced in the parts most highly differentiated (tuber parietale). The alterations in scurvy and osteogenesis imperfecta are presumed to be produced by what the author calls a "W-factor". He defines this factor as one which brings about abnormal dedifferentiation with abnormal increase in growth, acting generally on the tissues of the connective system and most strongly where the rate of growth is least. Consequently, the "N" and "W" factors stand in a certain antagonistic relation to each other. They have nothing to do with the real genesis of the diseases, however. The prevailing classifications of bone resorption are discussed, and reclassification is suggested under the headings: active, passive, and lingering resorption.

This book is highly recommended to all who are interested in the pathological physiology of bone and teeth.

CHRONIC RHEUMATIC DISEASES: BEING THE THIRD ANNUAL REPORT OF THE BRITISH COMMITTEE ON CHRONIC RHEUMATIC DISEASES APPOINTED BY THE ROYAL COLLEGE OF PHYSICIANS. Edited by C. W. Buckley, M.D., F.R.C.P. New York, The Macmillan Co., 1937.

This third report of the British Committee is well up to the standard of the other two volumes and brings out many points of interest for the student of rheumatic diseases.

The first chapter is a summary of the evidence against vaccine therapy. Sympathectomies are discussed with the following conclusion: So long as the cause of the disease remains unknown, operations on the sympathetic system should be regarded as purely symptomatic treatment, not as direct treatment of the disease. There is an excellent paper on x-ray therapy. The best results are obtained in inflammatory processes of the joint capsule and in periarticular inflammations. The newer knowledge of avitaminosis in rheumatoid arthritis shows that vitamin A and vitamin C in the serum are subnormal. Vitamin B is probably deficient as well, but this has not yet been demonstrated. In the chapter on chrysotherapy, the author concludes that, in the present state of knowledge, this form of therapy is of value in rheumatoid types of arthritis. There is an excellent chapter by Hench on recent investigations of diseases of joints and related structures in America, with a profuse bibliography.

The book gives one a great deal of food for thought and the sense that progress in the treatment of chronic rheumatic diseases is being made. It is well worth careful study.

CARCINO-OSTEOGENIC SARCOMA—A MALIGNANT MIXED TUMOR OF THE CHEST WALL: REPORT OF A CASE. J. W. Budd and Frank J. Breslin. *The American Journal of Cancer*, XXXI, 207, Oct. 1937.

The authors report a tumor occurring in the subcutaneous tissues just above the breast in a woman of fifty-nine. This tumor had been present for many years and grew rapidly for a year before operation. Following local removal, the patient has remained well for four years. Numerous photomicrographs illustrate the extraordinary pathology of the tumor, consisting in rapidly growing neoplastic epithelium and osteogenic tissue.

It seemed probable to the authors that there had been a sarcomatous transformation of the connective-tissue stroma of the carcinoma and that this sarcoma had assumed osteogenic properties.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

THE CORRELATION BETWEEN SERUM PHOSPHATASE AND ROENTGENOGRAPHIC TYPE IN BONE DISEASE. Helen Quinby Woodard and Norman L. Higinbotham. *The American Journal of Cancer*, XXXI, 221, Oct. 1937.

The authors have continued their studies on serum phosphatase and report in detail their findings in 203 persons with normal, benign, and malignant bone conditions seen at the Memorial Hospital. In general these findings confirm the conclusions reached in their earlier paper,—namely, that serum phosphatase is an indication of the amount of new bone formation taking place in the body, or of the attempt on the part of the body to form new bone, and is a measure of the functional rather than the histological type of the disease.

The paper presents detailed tables of the cases of primary and metastatic malignant tumors, with the determinations carried out in them.

The authors draw the following conclusions:

1. If a high serum phosphatase is found associated with an osteoplastic lesion or a normal serum phosphatase with an osteolytic lesion, then the phosphatase determination has served only to confirm the diagnosis made by the roentgenogram.

2. If a normal serum phosphatase is found associated with an osteoplastic lesion, then the process is probably slow growing and relatively benign.

3. If a high serum phosphatase is found associated with an osteolytic lesion, several possibilities present themselves:

   a. The case may be one of hyperparathyroidism. If this is so, the serum calcium and inorganic phosphorus will nearly always be abnormal and will serve to establish the diagnosis.

   b. There may be osteoplastic disease elsewhere in the body, which will account for the high serum phosphatase, even though the presenting lesion is osteolytic.

   c. The case may be one of a group made up chiefly of endotheliomata or carcinomata of diverse origin, metastatic to bone, which raise the serum-phosphatase level, but for some unknown reason do not form new bone. The presence of an elevated serum phosphatase may serve to distinguish these lesions from various types of benign osteolytic disease, which very seldom raise the serum phosphatase.

   d. The case may be one of an early highly malignant osteogenic sarcoma. Some of these fail to show new bone formation, probably because their very rapid growth rate outstrips the relatively slow deposition of calcium phosphate. Such tumors may show osteoplasia later in the course of the disease. In these cases the association of a high serum phosphatase with a rapidly growing osteolytic lesion probably indicates a high degree of malignancy.

4. Follow-up determinations of the serum phosphatase in cases with an initially elevated phosphatase may predict the development of metastases after the extirpation of the primary tumor, but cannot be depended on to do so.

5. Determinations of serum phosphatase in cases of bone tumors which have been treated by roentgen or gamma rays are useful in indicating the degree and permanence of the inactivation caused by irradiation.

6. While the presence of a normal serum phosphatase gives no assurance that bone disease is absent, the presence of a persistently elevated serum phosphatase in a patient who is not jaundiced and who is not under treatment with Coley's toxins is a very strong indication that bone disease is present and should never be disregarded.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

TRAUMA AS A FACTOR IN POTT'S DISEASE. Max H. Skolnick. *The American Review of Tuberculosis*, XXXVI, 429, Sept. 1937.

That trauma has a definite relationship to later development of Pott's disease is brought out by the author. Considerable time may elapse between the trauma and the

development of active disease, and the slighter forms of trauma seem to be a greater causative factor than severe injury. Symptomatology plays the most important part in the early diagnosis. Considerable time is required for such lesions to become clinically and objectively manifest, but if roentgenograms were taken in every case where symptomatology indicates possible activity, many cases would be discovered before irreparable damage had resulted.—*Clarence A. Ryan, M.D., Vancouver, B. C., Canada.*

INTERNAL FIXATION IN FRACTURES OF THE NECK OF THE FEMUR. Willis C. Campbell *Annals of Surgery*, CV, 939, 1937.

The author states that there are three types of fractures of the neck of the femur. The intracapsular or complete central type comprises about 43 per cent. of these fractures. It is in this type of fracture that non-union so frequently occurs. In the impacted and intertrochanteric types union can be expected in 100 per cent. of the cases.

The causes of non-union are impaired circulation to the proximal fragment, osteoporosis, inaccurate reduction, the sheering action of weight-bearing, the deleterious action of the joint fluid, and deficient blood clot. Lateral roentgenograms aid in determining whether or not a reduction has been accomplished.

For the treatment of the intracapsular type, Whitman in 1904 published his abduction plaster-fixation treatment by which union can be secured. In a survey made by a committee appointed by the American Orthopaedic Association in 1929 it was found that in 50.4 per cent. of 201 cases selected from well-known clinics bony union had been secured by the Whitman method in the complete central or intracapsular type of fracture.

The author was an adherent of the Whitman procedure, but now believes that internal fixation gives a higher percentage of excellent functional results and bony union, and decreases the time of non-weight-bearing from six to twelve months to four to six months, with less damage to the knee and hip joints. The author employs blind nailing, using the Smith-Petersen nail, and has so treated thirty-five cases of the intracapsular type.

A follow-up report of these cases is included in detail. The operative technique is described and illustrated.—*N. T. Kirk, M.D., San Francisco, California.*

THE REGENERATION OF BONE TRANSPLANTS. Hans May. *Annals of Surgery*, CVI, 441, Sept. 1937.

A review of the literature on this subject is presented and the author describes his own research as follows.

An investigation directed to the process of vascularization of a bone graft was carried out by subperiosteally removing the radius (including its two articular ends), placing the removed bone in salt solution and then replanting it in its original bed, and suturing the periosteum and closing the joint capsules. Twenty-five such experiments were performed on dogs, but aseptic healing occurred in only four animals. X-rays were made every eight days. The dogs were killed after five weeks, ten weeks, four months, and ten months, followed immediately in each case by injection of the axillary artery with a turpentine-mercury solution. The radii were removed, x-rayed, and studied histologically with the following findings:

The graft always dies after transplantation; many nucleii disappear, others degenerate, but in from two and a half to four months regeneration occurs by creeping substitution of dead bone by new bone. Small and large vessels grow from the periosteum into the graft; the former early regress as the large vessels progress until the entire graft is supplied by a well-arranged vascular system. That part of the graft not covered by periosteum becomes destroyed by ingrowing fibrous tissue and only small portions are saved by surviving osteoblasts. The periosteum, therefore, is the reliable factor in regeneration when an entire bone, with its closed medullary cavity, is transplanted.—*N. T. Kirk, M.D., San Francisco, California.*

INTERNAL FIXATION OF FRACTURES OF THE NECK OF THE FEMUR. Melvin S. Henderson. *Archives of Surgery*, XXXV, 419, Sept. 1937.

After a brief survey of the anatomy, with particular attention to the vascular supply of the upper end of the femur, the author discusses the operative treatment for fractures of the neck of the femur incidental to internal fixation. He reports sixteen cases and describes the use of the "lag" screw which is now being used in The Mayo Clinic. It is his feeling that the internal fixation of fractures of the neck of the femur gives better results than the conservative treatment, but that its use must be restricted to patients who can withstand operative shock.—*I. William Nachlas, M.D., Baltimore, Maryland.*

DISLOCATION AND FRACTURE-DISLOCATION OF LOWER CERVICAL VERTEBRAE. James Pierce Cole. *Archives of Surgery*, XXXV, 528, Sept. 1937.

Recognizing the many difficulties that follow the treatment of dislocations and fractures of the lower cervical vertebrae, the author presents a historical survey of this subject and then makes a study of the eighteen patients with this condition seen in the New York Orthopaedic Dispensary and Hospital between 1923 and 1933. His interest is not in the acute type of injury, but in the sequelae resulting from this. It is his feeling that the symptoms persist frequently, even when there has been a closed reduction. The symptoms may be referable to the bony structure, to the spinal cord, and to the nerve roots. If the spinal cord is involved, a laminectomy in conjunction with fusion is recommended; otherwise, fusion of the vertebrae adjacent to the point of injury is found desirable.—*I. William Nachlas, M.D., Baltimore, Maryland.*

EXPERIMENTAL GIANT CELL TUMOR AND CARTILAGINOUS EXOSTOSIS OF BONE. J. Dewey Bisgard. *Archives of Surgery*, XXXV, 854, Nov. 1937.

In the course of experiments on the bones of rabbits, injuries to the epiphyses were accidentally obtained. The repair that took place at these points led to the formation of tumors which had the characteristics of cartilaginous exostoses and, in two instances, of giant-cell tumors. Since the production of these new growths is based upon epiphyseal separation, a condition frequently seen clinically, a careful study of the tumors is made and some deductions are offered in which the experimental masses are compared with the changes which take place in man.—*I. William Nachlas, M.D., Baltimore, Maryland.*

SUI COSIDDETTI "TUMORI GIGANTO-CELLULARI" DELLE OSSA (THE SO-CALLED "GIANT-CELL TUMORS" OF BONE). Filippo Vecchione. *Archivio di Ortopedia*, LII, 547, 1936.

In this monographic presentation of the subject, a very good review of the literature is given, but no original thought is expressed. Vecchione considers the giant-cell tumor of bone as a well-defined nosological entity whose pathogenesis is unknown. He does not believe that bone cysts represent healed giant-cell tumors. It is still questionable whether or not these two forms are in genetic relationship. As far as treatment is concerned, both x-ray and surgical treatment are indicated. The latter ranges from simple curettement with or without caustic fluids to resection, osteoplasty, and amputation. Twelve personal cases are reported.—*Ernst Freund, M.D., Los Angeles, California.*

SUL TRATTAMENTO GLICOCOLLICO DELLA DISTROFIA MUSCOLARE PROGRESSIVA (GLYCOCOLL TREATMENT OF PROGRESSIVE MUSCULAR DYSTROPHY). Antonio Poli. *Archivio di Ortopedia*, LII, 667, 1936.

Poli has treated five cases of progressive muscular dystrophy (Duchenne type) with glycocoll for from three to four months. Only one case showed temporary improvement. In view of his clinical experience and of the studies of the creatine metabolism of these

patients, the author concludes that there is no practical value in glycocoll treatment and apparently no connection between glycocoll and creatine metabolism.—*Ernst Freund, M.D., Los Angeles, California.*

AUTOPLASTICHE OSSEE NELLE PSEUDARTROSI DEL COLLO DEL FEMORE (AUTOPLASTY IN PSEUDARTHROSIS OF THE NECK OF THE FEMUR). Carlo Re. *Archivio di Ortopedia*, LII, 689, 1936.

The author thinks that in the treatment of pseudarthrosis of the neck of the femur one should be very careful in selecting an operative method. In some cases a shelf operation is the method of choice; in others, the transcervical bone graft and subtrochanteric osteotomy are indicated. He has tried these different methods in various cases and has obtained good results.—*Ernst Freund, M.D., Los Angeles, California.*

INFANTILE KYPHOSIS. B. Frejka. *Bratislavské Lekarské Listy*, XVII, 375, Aug. 1937.

One of the causes of round shoulders and defective posture is constant nasal obstruction due to adenoids. The obstruction leads to buccal breathing which is superficial. The thorax becomes more or less fixed in expiration and a thoracic kyphos results with the apex over the sixth, seventh, and eighth vertebrae. This deformity produces subsequently a forward and downward displacement of the head, a depression in the anterosuperior joint of the thorax, and an increase of the lumbar lordosis. Prof. Frejka found this deformity in 80 per cent. of the children with adenoids. In 90 per cent. of the children affected with kyphosis, a nasal examination showed the presence of nasal obstruction, due either to adenoids or to hypertrophy of the mucosa. It ensues that for prophylactic reasons it is important to remove the adenoids in the preschool age and to reestablish the nasal breathing.—*Emanuel Kaplan, M.D., New York, N. Y.*

THE MOVEMENTS OF THE SHOULDER-JOINT: A PLEA FOR THE USE OF THE "PLANE OF THE SCAPULA" AS THE PLANE OF REFERENCE FOR MOVEMENTS OCCURRING AT THE HUMERO-SCAPULAR JOINT. T. B. Johnston. *The British Journal of Surgery*, XXV, 252, Oct. 1937.

The purpose of this article is to explain certain observations made by Martin and Codman in regard to rotation of the humerus during elevation of the humerus in any plane. It is believed that there is less confusion in referring the movements of the humerus in flexion and extension, abduction, and adduction to the plane of the scapula. This is regarded as a plane drawn at right angles to the glenoid cavity through its greatest vertical diameter.

"When the arm is raised to the vertical—no matter what plane or planes it may move through in the process—at the end of the movement the humerus must lie in the plane of the scapula." Full limit of elevation cannot be obtained until the movements of the humerus and scapula bring the two bones into the same plane. The writer does not accept Codman's paradox that the completely elevated arm is in either extreme external rotation or in extreme internal rotation. He offers a group of diagrams to prove that, when the arm is raised to the vertical above the head, the humerus is rotated neither to the medial side nor to the lateral side.

LAMBRINUDI'S OPERATION FOR DROP-FOOT. F. P. Fitzgerald and H. J. Seddon. *The British Journal of Surgery*, XXV, 283, Oct. 1937.

Twenty-four cases in which the Lambrinudi operation has been used are cited. The operation may be used for drop-foot or flail-foot. There have been five failures in the series due to lateral instability at the ankle.

Previous to the operation, the procedure is planned from tracings of lateral roentgenograms with the idea that in certain cases the patient will wear a tapering cork to

build up the back of the foot. Segments of the astragalus, os calcis, cuboid, and scaphoid are removed and the calcaneocuboid joint is cleaned out. The cartilage on the posterior surface of the scaphoid left after removal of a notch is not removed. The cuboid is brought up to the anterior surface of the astragalus and arthrodesed. Likewise the scaphoid is brought upward and forward which brings the forward part of the foot partially or completely up in line. The foot is fixed in a short leg plaster.

WIRBELLUXATION (Dislocation of the Vertebrae). Otto Wenzl. *Bruns' Beiträge zur klinischen Chirurgie*, CLXVI, 53, 1937.

In all cases of dislocation and fracture-dislocation of the vertebrae immediate reposition should be attempted. The author believes that operative treatment gives the best results. He feels that conservative treatment is advisable only in cases of dislocation of the atlas with subsequent operative fixation of the atlas. If the first two cervical vertebrae are wired, healing of the odontoid process can take place. In all other cases immediate operation should be performed, because the marked compression leads to irreparable damages. If the anterior compression is not removed, laminectomy is of no value and the extension treatment is ineffective for the thoracic and lumbar portions. The spinous process and the arch below the dislocation are removed. The luxated vertebra is replaced in its normal position by the use of bone hooks. The prognosis depends upon the amount of damage and the duration of the compression.—*Ernst Bettmann, M.D., New York, N. Y.*

DIE EPIPHYSENLÖSUNG IM SCHENKELHALS BEI JUGENDLICHEN (Separation of the Epiphysis of the Neck of the Femur in the Young). C. Gütig und A. Herzog. *Bruns' Beiträge zur klinischen Chirurgie*, CLXVI, 85, 1937.

In their cases the authors always observed symptoms of endocrine disturbances, especially in patients between the ages of ten and seventeen years. There was usually no history of trauma, the lesion being the result of an illness. In one case epiphysiolysis developed during absolute rest. The early symptoms, as shown by the roentgenogram, are: enlargement of the epiphyseal space, rarefaction, zones of calcification in the neck and head, coxa vara, and loss of the head. In the differential diagnosis the following conditions should be considered: tuberculosis, Perthes' disease, and aseptic necrosis of the femoral head. Treatment consists of organotherapy with extension and absence of weight-bearing.—*Ernst Bettmann, M.D., New York, N. Y.*

FRACTURES OF THE FOREARM. George W. Armstrong. *The Canadian Medical Association Journal*, XXXVII, 358, Oct. 1937.

This is a general article dealing with fractures of the forearm. The author gives an outline of the treatment which is generally recognized as proper. He emphasizes the importance of correct reduction, and believes that non-union, when it occurs in cases in which the fractures have been properly reduced, is due to the short period of fixation and to too early movement.—*D. E. Robertson, M.D., Toronto, Canada.*

ANTERIOR POLIOMYELITIS IN ONTARIO. J. T. Phair. *The Canadian Medical Association Journal*, XXXVII, 386, Oct. 1937.

The predicted epidemic of poliomyelitis, in keeping with its cyclic character of visitation, occurred in Ontario in 1937. There were thirteen cases before June 30. During the first two weeks of July, ten cases were reported; during the second two weeks, twenty-eight cases. There was an abrupt rise during August,—fifty-seven cases in the first week, seventy-three in the second, 230 in the third, 336 in the fourth, and 435 to September 4. From July 1 to September 4 there were 1,169 cases reported. (The epidemic continued to about the first of October.)

The incidence is more than ten times as great as for comparative periods in normal epidemic years. In comparison with 1929, when the disease was prevalent in Ontario, there were seven times as many cases up to the end of August. In comparison with 1930, when the most extensive previous outbreak occurred, there were three times as many cases for the corresponding period.

The geographical distribution for the month of August showed 54 per cent. of cases in Toronto and suburban areas.

Thirty per cent. of the cases diagnosed showed muscle weakness or paralysis.

"The Provincial Department of Health has attempted to assist the health authorities and physicians in the affected areas by placing at their disposal the services of specially trained physicians to aid in the diagnosis of doubtful cases. These diagnosticians have been located at convenient centres in those sections in which the disease is most prevalent. Sixteen physicians are engaged in this service. The Department has, further, placed respirators at strategic centres, and is prepared to ensure rapid transportation to those centres of all cases showing evidence of involvement of respiratory muscles. Every effort is being made to ensure the maximum of early orthopaedic treatment in all cases with paralysis."—*D. E. Robertson, M.D., Toronto, Canada.*

WIRBELBRÜCHE UND WIRBELVERRENKUNGEN; ENTSTEHUNG UND BEHANDLUNG DER QUERFORTSATZBRÜCHE. ANGEBORENE LENDENRIPPEN. [Fractures and Dislocations of the Vertebrae; Etiology and Treatment of Fractures of the Transverse Processes. Congenital Lumbar Ribs.] L. Böhler. *Der Chirurg*, VIII, 121, 1936.

The author emphasizes the importance of the differential diagnosis in cases of congenital lumbar ribs. The presence of gas bubbles proximal to this process should be taken into account. The margin of the psoas muscle, kidney stones, and epiphyseal spaces may obscure the diagnosis. The transverse processes play no part in the supporting function of the spine, and, for that reason, in the treatment the application of support by braces is not advisable. An operation is preferable when there is evidence of rupture of the soft tissues.—*Ernst Bettmann, M.D., New York, N. Y.*

OLD DISLOCATION OF THE HIP JOINT WITH FRACTURE OF THE ACETABULUM. A. Gruca. *Chirurgja Narzadow Ruchu i Ortopedja Polska*, X, 79, 1937.

The author reviews Campbell's work on posterior dislocation of the hip with fracture of the acetabulum and describes a complicated case of dislocation of the hip joint accompanied by a multiple fracture of the acetabulum. Examination of the patient two months after the accident showed a consolidated malunion of the acetabulum, paralysis of the sciatic nerve, posterior dislocation of the femoral head, and considerable impairment of function. The patient was operated upon. The acetabulum was reestablished; the posterior fragment of the fractured acetabulum was fixed in its proper place by a nail; the head was placed back into the acetabulum; and the neoplastic periarticular bone tissue was removed. Reexamination of the patient one year after operation showed absence of pain, limp, and shortening, almost normal flexion, extension and abduction of the thigh, and some restriction of adduction of the thigh and of dorsiflexion of the foot.—*Emanuel Kaplan, M.D., New York, N. Y.*

LA DESARTICULACIÓN INTER-ILIO-SACRO-PÚBICA. Dario Fernandez Fierro. *Cirugía y Cirujanos*, V, 169, 1937.

The author reports an interiliosacropubic disarticulation which he performed successfully on June 11, 1936, on a woman with a metastatic tumor of the ilium. From the location and character of the tumor, he believed that only this type of operation or that of Billroth-Jaboulay could save the patient's life. After a thorough review of the literature on this subject, consultation with his staff, and study of cadavera, the following technique was perfected.

An incision, two centimeters above the symphysis pubis and running parallel to Poupart's line and the crest of the ilium up to and level with the spine of the ilium, is made. From the anterior superior spine of the ilium another incision is made in the direction of the greater trochanter, through the gluteal furrow and the genitocrural furrow up to the point where the incision began.

The soft parts are then divided their full length following the line of the first incision, including the cellular tissue, the aponeurosis, the obliquus externus abdominis, the obliquus internus abdominis, and the transversus abdominis up to the preperitoneal cellular tissue. Great care should be taken to protect and isolate the spermatic cord in the male and the round ligament in the female. The psoas muscle is isolated and its superior portion is sectioned, and the femorocutaneous and genitocrural nerves are cut. The crural and the obturator nerves are next sectioned, a novocain solution having been previously injected. The common iliac artery and vein are then ligated temporarily or permanently if the ligation of the external iliac artery and the branches of the internal iliac artery can be done as they are being sectioned off. The external iliac artery is ligated at its extreme distal end, as was done with the obturator, to prevent the seeping of blood from the extremity as it is handled. The dissection of the peritoneum is continued anterior and posterior to the pelvic cavity, so that the region of the symphysis pubis may be completely uncovered and the bladder, the intestinal mass, and the ureter may be pushed back. The gluteus maximus is next divided, followed by division of the gluteus medius, gluteus minimus, and the piriformis to a point on a level with the greater trochanter; this is accomplished by rounding with the scalpel the superior, anterior, and posterior borders of the trochanter.

An incision, the full length of the crest of the ilium and a little below it, is made, so that the gluteal muscles may be detached along the full length of the external aspect of the ilium, the border of the sacrum, the coccyx, and the external surface of the greater sacrosciatic ligament. During this step, the gluteal and ischiatic vessels are ligated and, at this time, the decision as to whether or not to untie the ligatures of the common iliac artery and vein may be made. The dissection of the fold is continued and, at the level of the greater sciatic notch, the gluteal and greater sciatic vessels are divided. The sciatic nerve is sectioned off, a solution of novocain having been previously injected.

The dissected area is explored very carefully to make sure that the symphysis pubis is completely free. If the patient is a male, care should be taken to push back the spermatic cord, the penis, and the testicles; if a female, the same procedure should be followed with the round ligament. If this ligament has been cut, it should be fixed to the aponeurosis of the rectus, as is done when dealing with an inguinal hernia. The symphysis pubis is divided; the iliacus is separated; and the dissection is continued, keeping as close as possible to the descending ramus of the pubis. Hemorrhage can be controlled by compression. Finally, a point is reached at which the iliac bones cannot be separated further, and the dissection is carried through the posterior part of the pelvis to the sacro-iliac synchondrosis, and the iliacus is divided. After ligation of a few of the iliolumbar vessels, the disarticulation is begun, starting posteriorly. By so doing, the articular interline can be located, which permits a little more separation of the iliac bones. The final step consists of the division of the remaining soft tissues and the sacro-iliac and sacrosciatic ligaments. After this has been done, the extremity is detached, leaving a thick and well-nourished fold. The muscles of the fleshy fold are nourished by the muscles of the abdominal wall and the skin. A drain is left at the center of the fold.—*Carlos Finck, M.D., Torreon, Coah., Mexico.*

DIE PERIARTHRITIS HUMEROSCAPULARIS (Humeroscapular Periarthritis). Hans Schaer. *Ergebnisse der Chirurgie und Orthopädie*, XXIX, 211, 1936.

This complicated clinical picture, first described in 1872, is thoroughly analyzed and revised by the author. The affection presents various pathological changes. The following conditions are described: (1) post-traumatic stiffness, (2) lesions of the supra-

spinatus tendon (rupture, etc.), (3) bursitis, (4) apophysitis, and (5) arthrosis of the intertubercular sulcus and acromioclavicular arthritis. The author emphasizes the diagnostic importance of local tenderness above the following points: tuberculum majus, tuberculum minus, sulcus bicipitalis, processus coracoideus scapulae, and the acromioclavicular joint. Trauma to the supraspinatus tendon causes tenderness two inches outside the acromion in the center of the deltoid muscle. The Bettmann shoulder-ridge symptom (shortened neck and shoulder line, elevated shoulder) and atrophy of the supraspinatus and the infraspinatus muscles are often present. The painful locking in abduction between 60 and 100 degrees and painful rotation are pathognomonic. The rupture of the supraspinatus tendon is often due to degenerative changes associated with calcareous pseudobursitis. The existence of calcification is usually the result of an accident. The author often advises the application of a plaster-of-Paris cast. Radiation and novocain anaesthesia are also recommended.—*Ernst Bettmann, M.D., New York, N. Y.*

Die entzündlichen Erkrankungen der Kniescheibe (Inflammatory Diseases of the Patella). C. Blumensaat. *Ergebnisse der Chirurgie und Orthopädie*, XXIX, 310, 1936.

The following inflammatory diseases of the patella have been observed by the author: osteomyelitis (which is usually secondary), bursitis, tuberculosis, and lues. In osteomyelitis the change is due to the slower circulation and larger blood supply in the apophysis of the patella. The treatment consists of curettage, if total resection is not necessary. The tuberculous changes are accompanied with effusion, as is also bursitis, which, in contrast to osteomyelitis, is confined to the patella only. Early operation is recommended. The very rare lues of the patella is characterized by severe pain at night and marked periostitis. Tabetic changes are rather frequent and show marked atrophy.—*Ernst Bettmann, M.D., New York, N. Y.*

Die Tumoren der Kniescheibe (Tumors of the Patella). C. Blumensaat. *Ergebnisse der Chirurgie und Orthopädie*, XXIX, 347, 1936.

The most frequent tumors are osteomata and chondromata, with enlargement and shifting of the patella. Resection is recommended. Sarcomata, as periosteal and central tumors, grow rather slowly and in every case biopsy should be done. Myelomatous and carcinomatous metastases are rare and can be mistaken for osteitis fibrosa with giant cells.—*Ernst Bettmann, M.D., New York, N. Y.*

End Results in Fractures of the Shaft of the Femur. Eldridge L. Eliason and John Paul North. *Journal of the American Medical Association*, CIX, 848, Sept. 11, 1937.

The writers report seventy-four fractures of the femoral shaft treated by various methods. They advocate conservative treatment based upon the fundamental principles of fracture treatment.

In discussing different methods of traction, they point out that the one best suited to the individual case should be selected and that it must be continued uninterruptedly until firm union occurs. In their opinion, skeletal traction is next to operative reduction in efficiency. Russell traction is only fairly satisfactory and should be discarded for another method if good alignment is not obtained in a few days. In muscular patients with definite shortening, skin traction should not be employed. In small children, however, vertical suspension of both legs with the hips flexed to 90 degrees is considered the most effective.

Plaster-spica fixation may be used with caution in cases without displacement and in those in which callus holds the fragments together. Fresh fractures are apt to slip in

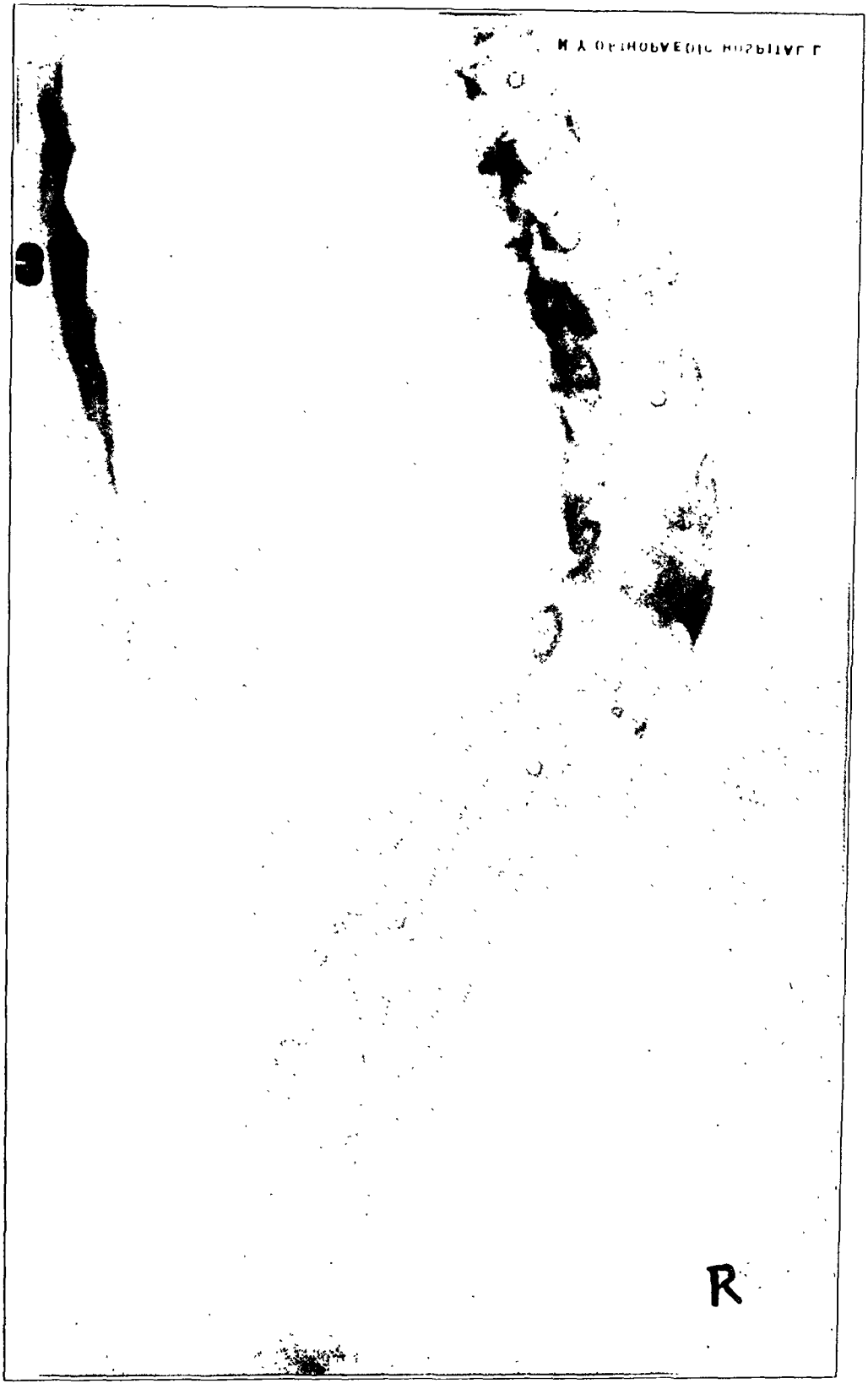



FIG. 5

Case 2. Preoperative roentgenogram, with patient standing.

plastic operation restores the normal angle of the radial articular surface, corrects the radial shortening, and produces a normal contour of the ulna. This is accomplished by a transverse osteotomy of the radius about one inch above the wrist. The medial portion of the distal one inch of the ulna is removed and is used as a bone wedge between the fragments of the radius. This is placed in such a manner that its widest portion lies dorsally and laterally thereby correcting both the radial deviation of the hand and the radial articular angle. The discus articularis is anchored subperiosteally or to the bone by means of a drill hole through the ulna.

Results in nineteen cases have been uniformly good. Of these, eleven known end results are excellent. In one other case the result was not satisfactory, as excess mobility of the distal ulna was present. This was due to a ruptured interarticular fibrocartilage. Advantages claimed by the author are the restoration of practically normal function and the correction of an unsightly deformity.—*W. B. Carrell, M.D., Dallas, Texas.*

THE CARE OF THE FEET IN CHRONIC ARTHRITIS. John G. Kuhns. *Journal of the American Medical Association*, CIX, 1108, Oct. 2, 1937.

According to Kuhns, the joints most frequently affected by chronic arthritis are those of the hands and the feet, but more attention is given to rehabilitation of the hands. Much, if not all, of the pain and deformity can be avoided by early and adequate treatment. He outlines the general measures used in treating over 1200 patients with this condition.

The only certain method of preventing late disability is by the avoidance of weight-bearing until the pain and swelling have subsided. Heat and immobilization may also be necessary at first, followed by graduated exercises. Finally, proper shoes with supports and correct posture are essential.

The most common condition of an untreated case is a foot rigid in valgus. Because weight-bearing is faulty, strains at the knee and hip are produced. There is atrophy of the intrinsic musculature and a subsequent flattening of the anterior arch. This is followed by pressure on the metatarsal heads, with resultant pain. This deformity further aggravates the inflammatory condition of the joints. Forceful correction under anaesthesia may be necessary in the late stages. Among late complications of chronic arthritis, the author mentions hallux valgus, contracted-toe deformity, ankylosis of the small joints, and spur formation on the tarsal bones. The latter is due in most instances to a chronic strain rather than to infection. Another disability of the arthritic foot is epidermomycosis. The impaired circulation of the foot causes this extremity to become frequently affected.

Both local and systemic treatments are indicated in caring for the feet of arthritic patients. Early and adequate measures will prevent painful complications and deformities. Good body alignment is also essential to ensure permanent cures.—*H. M. Childress, M.D., Dallas, Texas.*

FOOT DISORDERS IN GENERAL PRACTICE. Dudley J. Morton. *Journal of the American Medical Association*, CIX, 1112, Oct. 2, 1937.

The writer is critical of the view that most foot disorders are due to faulty shoes or to weakened musculature of the feet. In discussing the anatomy and the functioning of the foot, he states that the first metatarsal is of the greatest functional importance. In standing, it supports twice the load held up by the other metatarsals, and in motion it alone, with its associated muscles, sustains half of the greatly increased stress placed upon the foot. When there is a functional deficiency, as in a pronated unbalanced posture, the stresses are concentrated on the second metatarsal which soon shows hypertrophy. This pronation is due to a failure of the first metatarsal to carry its burden; there is a shift of weight medially; and a progressive condition is started which ends in a rigid flat foot.

the plaster fixation, and this should be watched for with frequent x-rays. Also, permanent damage may be done to the knee joint by long immobilization.

Surgery should be used as the last resort and in the authors' series the results did not justify the procedure.

The authors conclude that emphasis should be placed on restitution of function, and that perfect anatomical reduction is not essential. Skin traction on the thigh is least effective, it being satisfactory in only 11 per cent. of the cases in which it was used. Skeletal traction was adequate in 62 per cent. Perfect results were obtained in over 90 per cent. of the children in this series, whereas only 64 per cent. of the adults escaped without permanent disability.—*W. B. Carrell, M.D., Dallas, Texas.*

HYPERTROPHY OF THE LIGAMENTA FLAVA AS A CAUSE OF LOW BACK PAIN. R. Glen Spurling, Frank H. Mayfield, and James B. Rogers. *Journal of the American Medical Association*, CIX, 928, Sept. 18, 1937.

The authors believe that low-back pain, associated with objective sensory and motor neurological changes, is caused by an intraspinal lesion. They point out that the hyperplasia of the ligamenta flava as such a lesion is not generally recognized. The report is based on seven operated cases with this pathological finding. In six of them the lamina of the fourth lumbar vertebra was increased in thickness which might have been a part of the causative factor.

In each case the patient gave a history of trauma, radiating pain down one or both legs, and discomfort not relieved by recumbency. In four of the seven patients there was objective motor loss, two of them having definite atrophy. For diagnosis an adequate neurological examination is essential to differentiate between an extraspinal and an intraspinal lesion. If the total protein of the spinal fluid is elevated, a subarachnoid injection of two cubic centimeters of iodized oil is indicated. In the six cases in which this was done, a characteristic filling defect was shown opposite the fourth lumbar interspace. In order to obtain sufficient exposure, the laminae above and below the lesion were removed. The ligamenta flava showed marked hypertrophy with some areas of calcification. Microscopic examination showed a marked amount of cicatricial tissue. No signs of old or recent infection were present. To find the normal thickness of the lamina of the fourth lumbar vertebra, ninety-three spines were measured, and the lamina of the fourth was found to be about the same size as that of the third and fifth. The ligamenta flava in the lumbar areas of forty cadavera examined were found not to be hypertrophied at the fourth lumbar interval.

With the exception of one fatality from streptococcic meningitis, the results were excellent. Sensory and motor disturbances rapidly returned to normal. Three impotent patients recovered in from one to five days. Three returned to hard labor in six weeks. The writers conclude that this ligamentous hypertrophy was due to trauma. In the process of healing, or as a result of continuous trauma, an excess of scar tissue formed.—*H. M. Childress, M.D., Dallas, Texas.*

MALUNITED COLLES' FRACTURES. Willis C. Campbell. *Journal of the American Medical Association*, CIX, 1105, Oct. 2, 1937.

Presented in this paper is a surgical procedure for the restoration of anatomical alignment and the function of a wrist disabled by an old Colles' fracture unsuccessfully treated. In the author's opinion, malunion is due to one or more of the following: failure to obtain proper reduction; recurrence of deformity after apparent reduction; excessive comminution with radial shortening; complete rupture of the radio-ulnar ligament with undue mobility of the distal ulna; too early physiotherapy before firm union develops.

In describing this deformity, the author stresses in particular the radial deviation and the widening of the wrist. Simple osteotomy of the radius may aid in promoting function, but it does not correct the abnormal contour either of the radius or of the ulna. His

but, in general, local overgrowth is uncommon. Disturbed growth hormones may cause local hypertrophy, but the reasons for this are not known.

The writer points out that little is known of the causes for this upset in symmetrical growth and that such an undeveloped field should arouse the interest of research workers.—*W. B. Carrell, M.D., Dallas, Texas.*

THE PRACTICAL APPLICATION OF PHYSIOLOGICAL PRINCIPLES IN TREATMENT OF FRACTURES. Willis C. Campbell. *Khirurgiya*, I, 72, 1937.

The biology of the healing of fractures is reviewed, and basic principles of treatment are outlined. The routine treatment is summarized as follows:

1. Good reduction from inspection of the external contour checked by the roentgenogram.
2. Roentgenographic confirmation of reduction without removal of splints at the end of one week.
3. Removal of immobilization while callus is malleable, roentgenographic check-up, and correction of any angulation.
4. In certain fractures, continued protection for an indefinite period until absolute consolidation can be shown by roentgenographic and clinical examinations.—*Emanuel Kaplan, M.D., New York, N. Y.*

PATHOGENESIS AND THERAPY OF KÖNIG'S OSTEOCHONDRITIS IN CONNECTION WITH TWO CASES. M. Z. Rotenfeld. *Khirurgiya*, I, 93, 1937.

A description of a rare localization of osteochondritis is given. In two cases the process involved the lateral condyle of the femur, and in one case, the head and neck of the radius. The pathological diagnosis is differentiated from other processes in this area. The treatment consisted of iron and potassium-iodide therapy, with satisfactory results as far as function of the joints was concerned.—*Emanuel Kaplan, M.D., New York, N. Y.*

REDUCTION OF POSTERIOR DISLOCATIONS OF THE FOREARM. B. A. Peskin. *Khirurgiya*, I, 97, 1937.

The author reviews the known methods of reduction and describes his own. The patient is placed on a chair sidewise, with a folded towel under the arm pit of the injured limb to protect it from the back of the chair. The surgeon places his knee on the volar surface of the forearm near the elbow joint and produces downward pressure while the distal end of the forearm is first being supported and then slowly flexed by his hand. This method produces less trauma to the articular surfaces and does not require the application of great force.—*Emanuel Kaplan, M.D., New York, N. Y.*

THE TECHNIQUE OF REDUCTION OF SHOULDER-JOINT DISLOCATIONS. A. A. Kudryavtsev. *Khirurgiya*, II, 164, 1937.

A new method of reduction is described. The patient is placed horizontally, lying on the undislocated side with the arm stretched out along the body and the hand completely pronated to prevent him from lifting his body up while the actual reduction takes place. A cuff is attached to the wrist of the dislocated arm and by means of a cord is pulled up and fixed above in such a manner that the trunk of the patient is lifted slightly from the horizontal plane and the dislocated arm, abducted by the pull, forms an angle of about 110 degrees with the chest of the patient. To overcome the resistance of the muscles, the usual amount of morphine sulphate is injected before the reduction. It is claimed that reduction takes place in from one to five minutes, and is successful in cases where other methods fail.—*Emanuel Kaplan, M.D., New York, N. Y.*

In his estimation, most foot disorders are primarily due to a functional deficiency of the first metatarsal segment. Secondary changes are traumatic arthritis and strain upon ligaments of the long arch. There may be accompanying vasomotor changes in the foot, areas of numbness, and even radiating pain up the legs. Treatment consists of local applications to superficial irritation, rest and physiotherapy for the deep trauma and the inflammatory changes, and a correction of the disordered mechanics by changing the patient's shoes as indicated.—*H. M. Childress, M.D., Dallas, Texas.*

PAIN LOW IN THE BACK AND "SCIATICA" DUE TO LESIONS OF THE INTERVERTEBRAL DISCS. J. S. Barr, A. O. Hampton, and W. J. Mixter. *Journal of the American Medical Association*, CIX, 1265, Oct. 16, 1937.

Ruptures of the intervertebral discs are not rare according to the authors who report fifty-eight operated cases. Such pathology usually is found in healthy vigorous men from twenty to fifty years of age. A history of trauma was found in 80 per cent. of the authors' cases. Pressure upon one or more roots of the cauda equina produces signs and symptoms similar to those found in sacrolumbar and sacro-iliac strains with "sciatica". The most characteristic sign is a limitation of lumbar motion by muscle spasm. A list, to or from the affected side, is frequent. Neurological findings may be normal in about 50 per cent. of the patients. The most common positive neural sign is an absent or diminished knee jerk.

Roentgenographic examination revealed significant variations in but one-half of the cases. Schmorl's nodule was observed occasionally, but had no definite relationship to the condition discussed. Low lumbar puncture should be done in all suspected cases. Fifty-two patients of this series had a total protein of over forty milligrams per 100 cubic centimeters. If the spinal-fluid total protein is high, the diagnostic use of iodized oil is indicated. The lesions may be accurately localized with the oil injection. It must be controlled along the anterior and lateral surfaces of the canal, as this is where the pathology is found. No damage was produced by the use of this oil in any case. Serial x-rays of the oil in the canal are essential. The filling defects must be correctly interpreted. If no such defect is shown in the anteroposterior roentgenogram, the test is considered negative for evidence of a ruptured disc. Rupture of the fifth lumbar disc is difficult to demonstrate, and it is better to reexamine the patient two weeks after the injection. At this time the nerve sheaths and the lateral portion of the canal will be well outlined.

In thirty-two of the operated cases studied complete relief was obtained; in twelve improvement was noted; only two were classed as failures. The writers believe that no accurate clinical diagnosis of low-back pain with "sciatica" is possible without roentgenographic examination. Iodized oil should be used when conservative treatment is unsuccessful. The operative mortality is low, the percentage of cures high.—*H. M. Childress, M.D., Dallas, Texas.*

LOCAL OVERGROWTH. Fremont A. Chandler. *Journal of the American Medical Association*, CIX, 1411, Oct. 30, 1937.

The author believes that defective growth may be due to deficiency of germ plasm, circulatory failures occurring in early embryonic life, or epiphyseal disturbances. One or more of these factors may produce an overgrowth or an arrest of growth, locally or generally. Unilateral arrest of growth is treated successfully by shortening the well extremity. Bilateral arrest of growth, however, brings up the question of treatment with endocrine products and vitamin therapy.

Overgrowth is due to an epiphyseal stimulation which, in turn, is caused by an increase in the epiphyseal blood supply. Trauma, infection, foreign materials, and some chemicals at or near the epiphysis are the usual inciting factors. Arteriovenous fistulae and lymphatic obstruction by parasites may cause overgrowth, provided the condition occurs during the period of growth. Endocrine imbalances may be somewhat selective,

lesions, carditis, nodule formation, and multiple arthritis have been experimentally produced in animals.

Poynton and Paine originally explained rheumatism as a generalized secondary infection of the joints, heart valves, fascia, etc., coming from an original focus, the tonsils, just as a general infection producing multiple abscesses may originate from some primary purulent focus. However, just how this infection travels from the primary focus to the secondary locations is not explained nor understood.

The objections to the infection theories are based upon the fact that very seldom are streptococci found in the secondary lesions or in the blood stream, although they may be found in the primary lesion. This fact leads many workers to hold to the allergic theory. This theory pictures a local focus pouring into the body streptococcal poison or antigen. This antigen in the circulation stimulates the reticulo-endothelial cells to produce a specific antibody. If the production of antibody is good, the antigen is neutralized in the circulation and no harm is done to the body cells. However, if the antibody response is poor, the antigen combines with the antibody in the cells and produces cell destruction.

Studies in regard to the virus theory are still in the infantile stage, since highly specialized investigations are required and the accuracy of these studies depends on the skill of the laboratory investigators.

Rheumatism in adult life may be complicated by glandular dysfunction, climatic conditions, habits, occupation, injuries, etc. All or nearly all the glands have been incriminated, but the view now most supported is that two or more of them acting together are responsible.

The rôle of metabolic disturbances in rheumatism is uncertain. A patient who overeats and underexercises may develop a gouty tendency and thus be below normal in his ability to resist infections, but, outside of this observation, little else can be definitely stated in regard to the relationship of metabolic disturbances to rheumatism.

Injury and degeneration of the articular structures may play a part in old-age arthritis. In old age there is a diminished blood supply to the joints, with the result that the cartilages become thin and split and the exposed bone is worn down and roughened.

Fibrositis is an aspect of rheumatic involvement. Infectious (apparently) nodules form in fascia and tendon sheaths. These may come on slowly and last a long time. The ordinary stiff neck or "crick" in the neck gives symptoms similar to the rheumatic involvement of the same structures, yet it surely cannot be an infection developed in those muscles overnight. This leads us to consider the reaction of nerve endings and skin circulation to the system in general. These may also be factors in the onset of rheumatism.—*Herbert E. Hipps, M.D., Marlin, Texas.*

CHRONIC RHEUMATIC ARTHRITIS. H. Warren Crowe. *The Medical Press and Circular*, CXCIV, 426, 1937.

By the term "chronic rheumatic arthritis" the author means the residue of joint disease which is left after exclusion of acute joint disease, an injured joint, a specific arthritis, and gout.

The author discusses the symptoms, physical findings, and differential characteristics of rheumatoid arthritis and osteo-arthritis. His opinion is that the former is infectious in origin and the latter is degenerative, although there may be a mixing of the two types chiefly in older individuals.

Treatment of rheumatism consists of (1) prevention of deformity, (2) correction of existing deformities, (3) postural training, (4) physical therapeutic methods to increase muscle tone and to reduce pain and inflammation, (5) rest, and (6) vaccines.

As a rule, drugs have been unsuccessful, although aspirin and other sedatives are valuable.

Focal infection should always be kept in mind.

The author goes into detail in explaining how vaccines should be given. If a patient has any kind of a reaction following an injection, the dose should be decreased materially.

SOME PHYSIOLOGICAL ASPECTS OF NATURAL AND ARTIFICIAL SUNLIGHT. F. S. Cooksey. *The Medical Press and Circular*, CXCIV, Supplement, i, 1937.

It is generally accepted that artificial sunlight for therapeutic purposes refers only to the ultra-violet rays, and only these rays are considered in this article. The rays adjacent to the visible spectrum are referred to as the long, near, or biotic rays (3900 A. to 2900 A., *A* representing the Angström unit of wave-length) and the remainder as the short, far, or abiotic rays (2900 A. to 1800 A.). The long rays are stimulating to animal and vegetable protoplasm, while the short rays are destructive.

The abiotic rays may be used therapeutically to sterilize the skin in acne and multiple furuncles, the surface of indolent wounds and ulcers, and the conjunctival sac as a preliminary to ophthalmic operations, etc. They do not penetrate below the stratum corneum of the skin and will be almost completely absorbed by the air if the patient is more than two feet away from the radiating source. The abiotic rays are not present in the natural sunlight at the earth's surface, being absorbed by the atmosphere.

The erythema reaction to the biotic rays varies with the amount and character of ultra-violet rays absorbed, and is most pronounced with rays of about 2970 A. The first-degree erythema causes only a brief slight flushing of the skin and no discomfort. In the second degree the skin is a bright pink, there is some irritation, and fine peeling and pigmentation follow in a few days. In the third degree there is intense redness with much discomfort lasting some days and followed by coarse peeling and deep pigmentation which may persist for many months. The fourth-degree reaction is a blister, followed by scarring.

The first-degree and second-degree reactions provoke a cutaneous vasodilatation which may last forty-eight hours. They effect an acceleration of the functions of the skin, and secretion of sweat and sebaceous glands and excretion of urea are increased.

It may be said that exposure to sunlight raises the subnormal but does not affect the normal physiological activity of the skin. Patients with low vitality following debilitating illnesses respond well to sunlight. Much of the value of sunlight lies in the fact that the cutaneous stimulus is sustained, while it fades with the cessation of other treatments such as heat, cold baths, exercise, etc. Pigmentation varies with the degree of erythema produced. The pigment absorbs ultra-violet rays and converts the energy into heat. As the pigment deepens, a longer exposure becomes necessary to produce the same reactions. The function of the pigment is to protect the body against excessive exposure to sunlight; if several weeks are allowed to pass without exposure, a smaller dose is required although pigmentation persists.

Activated by the ultra-violet rays, ergosterol is converted in the skin into vitamin D; the antirachitic rays are sharply defined about 2980 A. Sunlight prevents and cures rickets by supplying the necessary vitamin for the regulation of the calcium and phosphorus metabolism of bone.

Ultra-violet rays have a stimulating action coincident with the onset of erythema and a late sedative action an hour or so later. Drowsiness is commonly experienced during irradiation. If the dose has been excessive, the absorption of breakdown products, following wide-spread destruction of epidermal cells, gives rise to general malaise, nausea, and headache, and later to soreness of skin, mental irritation, and restlessness.—*Herbert E. Hipps, M.D., Marlin, Texas.*

THE "NATURE" OF RHEUMATISM. F. J. Poynton. *The Medical Press and Circular*, CXCIV, 416, 1937.

After forty years of intense work and study on rheumatic disease, the infection theory still holds the most prominent place, although the exact nature of the infection and its mode of action are still warmly contested.

Investigations based upon the streptococcal-infection theory have taught us the meaning of the local focus, and, with micrococci obtained from these foci and rheumatic

DES RAIDEURS ARTICULAIRES APRÈS LES BUTÉES OSTÉOPLASTIQUES DE HANCHE (ARTHROPATHIES POST-OPÉRATOIRES). [Articular Stiffness after Osteoplastic Shelf Operations on the Hip (Postoperative Arthropathies).] Tavernier et Albert Trillat. *La Presse Médicale*, XLV, 1051, 1937.

The articular pain which is so common in hips about which osteoplastic shelves have been turned down constitutes a special category of postoperative arthroses. They appear invariably in patients past the age of five, in whom the femoral head has been forcibly brought down to the level of the acetabulum and the shelf acts as an efficient block to dislocation. The condition is characterized by a true articular stiffness, which frequently does not yield even under anaesthesia. Pain is not present and deformities do not develop.

The x-ray shows osteoporosis, without narrowing of the joint outline. For a period of about three years the stiffness persists; then gradually the mobility present before operation returns. During this time the bone undergoes a gradual osteoporosis for a period of about two years and then gradually recalcifies.

The authors attribute the condition to capsular tissues. They consequently recommend that no effort be made to pull the femoral head down in those cases in which a shelf operation is contemplated. They further caution against any hasty arthroplastic procedures in these cases of postoperative arthroses.—*Henry Milch, M.D., New York, N. Y.*

L'ÉTIOLOGIE DU TORTICOLIS MUSCULAIRE (The Etiology of Muscular Torticollis). Werner Schmid. *La Presse Médicale*, XLV, 1189, 1937.

The opinion is expressed that the origin of torticollis is to be sought, not in the mother, but in the foetal structures. The muscular ischaemia is brought about first by a perifoetal cause, oligohydramnios, due to abnormality of the foetal membranes; and second by an endofoetal cause, a failure of normal differentiation of the mesenchyme. A genealogical table is added. The author is of the opinion that "torticollis is a hereditary disease, recessive in the genotype and probably bihybrid".—*Henry Milch, M.D., New York, N. Y.*

QUAND ET COMMENT PRATIQUER LA VACCINATION PAR LE BCG (When Should Vaccination with BCG Be Undertaken)? Jean Paraf et Boissonet. *La Presse Médicale*, XLV, 1307, 1937.

The authors insist upon the value of vaccination against tuberculosis by means of Calmette's BCG. They note that the vaccine has not proved of much value in those children who are subject to repeated massive infection from parental sources. On the other hand, if the children are removed from these contacts and are subject to only casual infection, the method has proved definitely valuable. In such cases the vaccination need not be undertaken before the age of six.—*Henry Milch, M.D., New York, N. Y.*

REFLEXION SUR LE SYNDROME D'EMBOLIE ARTÉRIELLE DES MEMBRES (The Syndrome of Arterial Embolism of the Extremities). Marc Iselin et R. Heim de Balsac. *La Presse Médicale*, XLV, 1373, 1937.

The authors performed arteriotomy for thrombosis in four patients. Three of these patients died and careful post-mortem examinations were possible. The authors draw the following conclusions:

1. In cases which are clinically typical of embolism, the punitive phenomenon is that of loss of arterial pulsation. This segmental arterial paralysis can be explained only on a regional nerve basis.

2. The clot forms secondary to the cessation of arterial pulsation.

3. The arterial-trunk circulation and circulation to the extremities are entirely independent of each other.

Rest is itself an extremely important part of the treatment of such a condition.

Recalcification of the bone, improvement in the blood picture, and gain in weight and general health are important signs of recovery, and they sometimes occur before pain reduction. Proper attention to all these details over a long period of time is necessary before a cure can be obtained.—*Herbert E. Hipps, M.D., Marlin, Texas.*

HALLUX VALGUS: STUDY OF END RESULTS OF 339 BUNIONECTOMIES. W. R. Hamsa. *Nebraska State Medical Journal*, XXII, 225, 1937.

Dr. Hamsa presents a splendid and timely paper on the subject of hallux valgus. There is so much conflicting information on the subject in medical literature, and so many different methods of operative repair are described by various authors, that to the average practitioner the subject presents a picture of the wildest confusion. Dr. Hamsa has very carefully compiled a table of all the various procedures used in the treatment of this condition, and has made a careful study of the etiological factors involved.

He states that in the Orthopaedic Department at the University of Iowa there have been performed 339 operative corrections with a postoperative follow-up ranging from two months to a maximum of twenty-two years. As the McBride and Brandes techniques have only been used for the past four years, the series for these particular operations is quite small. The following is an abstract of a table presented by the author: The simple Silver osteoplasty produced good results in 79 per cent.; excluding the arthritics, good results were obtained in 87 per cent. The Mayo osteoplasty gave good results in 91 per cent.; with arthritics excluded, 92 per cent. With McBride and Brandes osteoplasties good results were obtained in 86 and 67 per cent.

In conclusion the author states that congenital anomalies play only a minor rôle in the production of hallux valgus. Extrinsic forces (improper shoes, etc.) contribute directly in most cases to the formation and the recurrence of hallux valgus. Conservative treatment improves many early cases. Simple correction of the exostosis without correction of the deviation (if not over 15 to 20 degrees) is the most logical treatment in women who wish to wear dress shoes. In the absence of arthritic changes the Silver and McBride operations are the best. Where arthritic changes are present, the Mayo osteoplasty is apparently the best. Associated small toe deformities should be corrected. Metatarsus primus varus of from 15 to 20 degrees should be corrected along with the hallux valgus, base correction being more logical and affording better results than shaft osteotomy.—*William R. Malony, Jr., M.D., Iowa City, Iowa.*

PNEUMOROENTGENOGRAPHY IN THE DIAGNOSIS OF THE LESIONS OF THE KNEE JOINT. A. Lachowicz and M. M. Goldman. *Polski Przeglad Radjologiczny*, X and XI, 35, 1936.

The authors use an improved technique of pneumoroentgenography and present a series of excellent x-rays demonstrating the possibility of diagnosis in cases of injury to the menisci, in Hoffa's disease, in cases of intra-articular free bodies, and in inflammatory conditions of the synovia. They also mention the diagnostic possibilities in osteochondritis dissecans and chondropathy of the patella.—*Emanuel Kaplan, M.D., New York, N. Y.*

OSTEOMYELITIC INVOLVEMENT OF THE SHOULDER AND HIP JOINT. M. Schieber. *Polski Przeglad Radjologiczny*, X and XI, 92, 1936.

In a personal investigation of several cases, the author found characteristic changes in osteomyelitis of the hip and shoulder. There are early small foci of decalcification sometimes revealing the presence of minute sequestra and a very mild periosteal reaction. If the process begins in the acetabulum, small excavations filled with sequestra appear. The roof of the acetabulum usually remains intact, the most frequent complication being the separation of the epiphysis, followed by destruction and dislocation. Similar changes were observed in the shoulder joint.—*Emanuel Kaplan, M.D., New York, N. Y.*




FIG. 6

Case 2. Pelvic-tilt examination. Patient sitting with left side of pelvis elevated.

4. Arterial paralysis is a consequence of arterial-trunk injury.

This fundamental conception forms the basis for arteriectomy, as practised in these cases. Either arteriectomy or arteriotomy for embolectomy may release the arterial paralysis and so prevent gangrene.—*Henry Milch, M.D., New York, N. Y.*

PIED BOT ET HÉMIPLÉGIE FRUSTE (Club-Foot and Unsuspected Hemiplegia). André Thomas. *La Presse Médicale*, XLV, 1333, 1937.

Attention is called to the fact that club-foot may be due to an unsuspected hemiplegia. This may be brought to light by careful examination of the tonicity of the muscles, by the response to stimulation, by the voluntary or involuntary motility of the involved extremity, etc. In the very mild cases these observations may be made, even in the absence of any reflex signs of pyramidal-tract involvement.—*Henry Milch, M.D., New York, N. Y.*

CONSIDÉRATIONS SUR LES RHEUMATISMES ET LEUR TRAITEMENT (Rheumatism and Its Treatment). J. Le Calvé. *La Presse Médicale*, XLV, 1409, 1937.

The author has treated 155 cases of all types of "rheumatism" on the basis of a sulphur deficiency, associated with a hypovitaminosis. These include twenty-four cases of sciatica, acute articular rheumatism, psoriatic arthropathy, chronic rheumatism, acute infectious rheumatism, etc. The percentage of satisfactory results is not given.

The treatment consists of a diet rich in vitamins, sulphur injections, and autohemotherapy,—twenty cubic centimeters every four to five days.—*Henry Milch, M.D., New York, N. Y.*

OSTÉOSES ET PÉRIOSTÉOSES PAR CARENCE ALIMENTAIRE CHRONIQUE (Osteosis and Periosteosis Due to Chronic Alimentary Deficiency). G. Mouriquand, H. Tete, et P. Viennois. *La Presse Médicale*, XLV, 1419, 1937.

In an earlier work the authors showed that it was possible experimentally to reproduce the syndrome of chronic rheumatism by dietary deficiency. In the present essay they show that, in contrast to animals submitted to a total scorbutic diet, animals which were given diets only partially deficient in vitamin C preserved a state of relative eutrophia. They developed the typical osseous tumefactions due to subperiosteal hemorrhages. If treated within the first twenty-five days, these tumefactions disappeared. If the experiment was persisted in longer, the tumefactions gradually ossified and were associated with articular stiffness, clinically resembling an ankylosing arthritis.—*Henry Milch, M.D., New York, N. Y.*

THE VALUE OF THE OBLIQUE VIEW IN THE RADIOGRAPHIC EXAMINATION OF THE LUMBAR SPINE. S. A. Morton. *Radiology*, XXIX, 568, Nov. 1937.

This projection, called the Dittmar position, is made as follows: The patient is placed on a flat Bucky table, with the legs extended, and is raised 45 degrees toward the side to be examined,—that is, if the right facets are being examined, the left side is raised. Sand bags steady the patient in position. The exposure will be about two and one-half times that given for an anteroposterior projection.

The superior and inferior articular processes should be well shown and the zygapophyseal joints definitely outlined. Pointed or irregular ends of articular processes indicate pathology. The "pars interarticularis"—that part of the posterior arch where the lamina and inferior articular process join the base of the pedicle and transverse process—is a vulnerable region and can be visualized adequately only in the oblique position.

Separations in the neural arch of the last lumbar vertebra, as in spondylolisthesis, are best shown in the oblique view, which also helps greatly in deciding whether such separation is possibly due to trauma. Subluxations of the zygapophyseal joints and the

degree of subluxation are best seen in this projection. It is often possible in this position to get a view straight through at least the upper part of a sacro-iliac joint.—*Edward N. Reed, M.D., Santa Monica, California.*

LAS PARÁLISIS DEL NERVIO CUBITAL EN LAS FRACTURAS DEL CODO (Paralysis of the Ulnar Nerve in Fractures at the Elbow). Vincente Sanchis Olmos. *Revista de Cirugía de Barcelona*, XII, 82, 1936.

In the histories of 600 cases of fracture at the elbow, forty-two (7 per cent.) were found in which the ulnar nerve was affected, either alone or with other nerves. There were twenty supracondylar and six epitrochlear fractures, eight fractures of the external condyle, one fracture of the olecranon, and seven fractures of other types. Six patients had paraesthesia but no loss of sensation or paralysis. Twenty-two had paralysis in part of the ulnar distribution, and fourteen had complete paralysis.

Treatment consists of prompt reduction of the deformity and skeletal traction where it is possible. Surgical intervention is necessary where serious nerve injury is suspected or where nerve involvement is present after the fracture has been corrected. Six patients had operations. One had contusion of the nerve and subperineural hemorrhage. In two patients a pseudoneuroma developed from chronic contusion in abnormal position. One patient had no change at the level of the fracture, but the nerve was compressed in fascial scar at a lower level. Two patients were cured and four were improved.—*Edward Francis Keefe, M.D., Brooklyn, New York.*

THE NON-OPERATIVE TREATMENT OF FRACTURES AND DISLOCATIONS OF THE SPINE. Edward Thomas Newell. *Southern Medical Journal*, XXX, 799, Aug. 1937.

Spinal fractures are often overlooked in the first week after an injury. They should always be suspected and looked for. Fractures of the cervical spine are treated by head traction and hyperextension by means of a head halter and weight and pulley. This treatment is followed by the application of a plaster cast. Fractures lower down the spine are treated on a hyperextension frame with or without traction, followed by a plaster jacket for three to six months, then a back brace for six months or longer.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

THE SURGICAL TREATMENT OF LOW BACK PAIN AND SCIATICA. Ralph K. Ghormley and Harrison R. Wesson. *Southern Medical Journal*, XXX, 806, Aug. 1937.

The authors have reviewed all the cases of low-back pain treated by bone-fusion operations at The Mayo Clinic. They conclude that a fairly high percentage of cures can be obtained by fusion of the lumbosacral and sacro-iliac joints. More accurate diagnostic methods are proving of greater help in selecting cases for operation.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

A REVIEW OF CASES OF CONGENITAL DISLOCATION OF THE HIP TREATED AT THE NORTH CAROLINA ORTHOPEDIC HOSPITAL. W. M. Roberts. *Southern Medical Journal*, XXX, 987, Oct. 1937.

This is a review of forty cases, and the author advocates the application of preliminary traction before doing an open operation. This he thinks has facilitated the operation, reduced the time, and lessened the danger of trauma to the head of the femur. The choice of cases for open or closed reduction is not made according to age, but according to clinical and roentgenographic findings. In the majority of cases of open reduction, some sort of shelving operation is also done.

There were eight recurrences after reduction—two after open operation, and six after closed reduction. Sixty-four per cent. of the cases showed some changes in the femoral head after open reduction, and 60 per cent. showed similar changes after closed reduction. In the cases in which closed reduction was done better end results were obtained than in the cases in which open reduction was done. This may be due in part to the higher age incidence in the latter cases.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

A Case of Alternating Scoliosis with Proven Etiology. Robert A. Milliken. *Southern Medical Journal*, XXX, 1099, Nov. 1937.

The author reports the case of a woman, twenty-four years of age, who complained of pain in the right hip and leg of seven months' duration. She gave a history of a fall one month previous to the onset of symptoms. Various types of treatment had been tried without relief. Examination revealed a slender woman with extreme left sciatic scoliosis on standing. Marked flattening of the lumbar curve and forward leaning of the body from the hips were noted. She could bend forward freely, but attempts to stand erect caused a great increase in pain in the right leg down the sciatic nerve to the knee. When supine, the patient involuntarily shifted to a right scoliosis. At operation the spine of the first sacral segment was found to be abnormally long and hook-shaped, extending upward to meet a correspondingly long spinous process of the fifth lumbar segment which had a cartilaginous elongation. The two processes were not joined, but were in contact even in the flexed operative position. Extension of the spine made the processes slip by one another, and a slight twist of the pelvis could make them overlap on one side or the other. This caused an alternating scoliosis. Spinal fusion of the fourth and fifth lumbar vertebrae and the sacrum was done. One year later the patient's back was normal.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

Early Weight Bearing in Fracture Dislocation of Ankle Joint. Aaron H. Trynin. *Surgery, Gynecology and Obstetrics*, LXV, 379, Sept. 1937.

The writer sets forth three objectives in the treatment of these fracture-dislocations: (1) *reduction*; (2) *maintenance*; (3) *functional return*, the time and degree of which depend upon the former two plus early weight-bearing. Reduction and maintenance are accomplished by methods described by Böhler. Weight-bearing with a cane is started within a few days after the application of the non-padded cast and walking iron. The use of crutches is not permitted. Recurrence of displacement is not encountered. A period of from eight to ten weeks of walking in plaster is followed by from two to three weeks of physiotherapy. Apparently the same procedure without true early weight-bearing adds two to three months to the treatment period.—*Richard McGovney, M.D., Santa Barbara, California.*

Fractures in Children. J. Dewey Bisgard and Lee Martenson. *Surgery, Gynecology and Obstetrics*, LXV, 464, Oct. 1937.

The writers present some clinical and experimental studies with conclusions concerning the influence of trauma, particularly fractures, on the epiphyseal cartilage. Two hundred and thirty-two fractures of long bones in children were reviewed. In forty-nine the epiphyseal cartilage was involved. Only twenty-eight cases were followed over a year. Eight of these patients had deformities due to growth disturbance. The authors estimate that in 10 per cent. of fractures in children the epiphyseal cartilage is involved. Most growth disturbances are insignificant. Of the 232 fractures, 3.5 per cent. presented demonstrable deformities due to growth disturbance. Whenever infection was present, growth was arrested. Repeated manipulations increased the incidence of growth disturbance. It is preferable to be content with a reduction less than anatomical than to do multiple manipulations or open reductions. Four out of five of the cases in which open reduction was done showed changes. Internal fixation penetrating the cartilage is practically certain to produce growth arrest. Experimentation was done on nine young goats, and the growth changes were noted.—*Richard McGovney, M.D., Santa Barbara, California.*

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# The Journal of Bone and Joint Surgery

## THE PRESIDENT'S ADDRESS

### A PLEA FOR THE FUNDAMENTAL PRINCIPLES OF ORTHOPAEDIC SURGERY *

BY A. BRUCE GILL, M.D., PHILADELPHIA, PENNSYLVANIA

*Fellows of the American Academy of Orthopaedic Surgeons:* It is a great honor to stand here to address you as your President. This Academy has justified the foresight and the wisdom of its founders and today constitutes the largest body and one of the most important organized groups of orthopaedic surgeons in the world.

I feel your power and enthusiasm and ambition. I can gain a glimpse of the tremendous possibilities of your future. You have made me your leader for the moment. How should I attempt to counsel you; whither should I try to guide you?

Should I attempt to instruct you in knowledge? You could teach your President many things. Should I point out to you new fields of endeavor? Your own genius is constantly driving you into these unexplored realms. Should I stimulate you to greater accomplishment? You are even now bursting with energy and ambition. How then shall I address you? Is there anything of myself that I can give to you, whether you accept it or not?

As an older man than many of you who are sitting before me, as one trained in the old and more conservative methods of orthopaedic surgery and yet familiar with the new, as one with a little longer experience and possibly a certain judgment gained thereby, I may serve for you as a bridge between the past and the present, as can also my contemporaries here. What is has grown from what was. Not all of our older methods and experiences were useless; not all of our present ones have yet been tested and proved by time.

We should not forget that the orthopaedic surgeon made a useful place for himself and his art, often in face of opposition by the general surgeon. He observed the laws of growth and repair; he studied physical

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 18, 1938.

and mechanical principles in their application to the human body; he learned the value of rest and the means to secure it in the presence of inflammation. Above all, he stressed the function of the body, its preservation and its restoration, as the ultimate end of all treatment. He never for a moment lost sight of this. Treatment of a case might continue through months and years, but at the very beginning he had a clear mental picture of the final result to be accomplished. Surgical operations were employed, but they were often only an interlude between the preoperative and the postoperative phases of the treatment. He was skilled in manipulation with his hands and used the knife as a last resort. He was thoroughly conversant with the value of physical therapy and the indications for its use.

Surgery, as derived from two Greek words, means to work with the hands. In a broad sense a surgeon is one who practises the healing art with his hands,—whether it be by massage, by manipulation, or by the use of instruments and appliances. However, since the advent of asepsis, the skillful use of the knife has become, properly or improperly, the distinguishing talent and criterion of the great surgeon; and there has been a growing tendency to neglect, to delegate to persons who are not members of the medical profession, and even to discard entirely all the arts of surgery but the use of instruments and mechanical apparatus.

Directly and indirectly because of these self-limitations of the modern surgeon, there have arisen various schools of therapy and thousands of practitioners whom we choose to call irregular because they are outside the ranks and beyond the control of the organized medical profession. Strange to relate, many of them—such as the bone-setter, the chiropractor, and the osteopath—claim to heal by the use of their hands; and to our surprise and astonishment, to our embarrassment and chagrin, they succeed at times where we fail.

In this mechanical age there has been a tremendous production of all kinds of laboratory devices and of machines, instruments, and apparatus for the diagnosis and the treatment of medical and surgical conditions. Consequently, there has been a marked tendency among medical students and practitioners to rely upon these aids rather than upon their own natural powers of observation and the skillful use of their hands. Do we not like too well to shift the responsibility of diagnosis upon the laboratory technician and the roentgenologist? And do we not accept too readily the assurances of salesmen that their costly electrical machines will heal all kinds of disease and that their complicated apparatus will cure all fractures? Let us not forget that our hands are the finest and most cunning instruments ever made. Do we persistently cultivate their skill in diagnosis and treatment?

There is some resemblance today between the changing conditions in Medicine and Surgery and those in Society and the Body Politic.

The course of the arts and sciences has always been related in a general way to social and political order. During periods of upheaval,

of oppression, and of tyranny they have languished, but when a great crisis has been successfully passed and peace, quiet, and order prevail they have flourished. The Greek genius, unsurpassed in the history of the world, that sprang up as naturally and as universally as flowers in the fields, reached its greatest heights after the Persian Wars. The Golden Age of Augustus followed the civil wars of Rome and the consolidation of the empire. The Elizabethan Era came after the Spanish menace had been beaten back and England had entered upon her long and glorious history of freedom and wealth. The American War of Independence and the French Revolution brought to the citizen relief from oppression by the State and the Church and opened the gates to Science which since then has made unbelievable advance.

Then came the Great War which again stirred the world to its depths, and we are now at the beginning of another period of change and readjustment. There is a striving for some new and different freedom, a freedom from poverty and want and worry and anxiety both present and to come, a relief from oppression by class and by wealth and power of individuals and groups of men and corporations. And there is much confusion of thought, of purpose, and of methods. There seems to be too great an inclination to discard the old and to try the new, no matter what or how unproved by time and experience. The lessons of history may be forgotten, the fundamental principles of human nature, which are the basis of individual conduct, of social relations, and of law and order, may be overlooked.

Some peoples have lost faith and confidence in their own powers to reach the ideal and have surrendered their individual rights and liberties to a dictator who promises them national and individual security. To attain a new end they have forgotten and have lost that for which our forefathers fought, the inalienable rights of the individual which no state or form of social organization can take away by force or accept by surrender of the majority. As long as one man lives in whom breathes the spirit of liberty and of justice, the freedom of the human soul cannot be destroyed. Disaster to medicine, art, music, letters, science, and religion has followed swiftly upon the loss of individual freedom.

We must not forget in this present period of confusion and rapid change that there are fixed, established, and undying principles of right and of liberty proved by centuries of happy experience, and we must not sacrifice these in the hope of gaining some new end, good though this end may be in itself. It will prove but a false dream that lures us to destruction. There are no "New Deals" and "New Eras" unrelated to the past and essentially different from them. There are no new principles of right and wrong, of freedom and oppression. The virtues and the vices of men persist, and it is difficult to see that there is less selfishness, less grasping for power, less enmity, and less strife to possess that which belongs to another than in times gone by.

It cannot be denied that there is this deep unrest in the world today,

this striving upward for something which may vastly benefit civilization, ill-defined and chaotic as this urge may be. As men of intelligence and as physicians we cannot ignore it and cling pertinaciously to the past or drift idly with the current. We must aid in finding solutions to these new problems, which, however, may not be attained in our generation, without selfishness, injustice, strife, violence, and tyranny either by the minority or by the majority, and without loss of individual liberty and the right of property upon which our whole civilization rests.

However, apart from these general but vital considerations, I think I can see in our own particular profession some evidence of this same spirit of unrest. There is some tendency to discard the older and conservative methods in surgery, many of which required time and patience and exact attention to details, and to adopt almost overnight, as it were, newer methods which promise much but which have not yet stood the test of time. The former require intimate knowledge of anatomy and physiology and the mechanics of the body. The latter may require only skillful operative technique: New operations or modifications of old ones have appeared by the score,—some to be found useful and to become classic, many soon to be discarded and forgotten.

There appears to be a tendency to neglect the study of the fundamentals of surgery and to place our sole reliance upon methods and fads and gadgets. Consider how many appliances there are for the reduction and immobilization of fractures. It has become the vogue, I might almost say the fad, at the present time to employ them almost entirely and to the exclusion of the older methods of reduction and fixation. Most of them are unnecessary to the surgeon who is familiar with the simple laws of mechanics, who is versed in the principles of fractures, and who has acquired skillful use of his hands in manipulation and in the application of fixation dressings. To treat all fractures by a certain rule and by some special apparatus, as if the rule supplanted the use of the brain and the apparatus that of the hands, is both ridiculous and futile. I wage no war against gadgets in themselves. They often delight one with their neatness, their mechanical nicety, and their efficiency in saving of time and energy. However, I do object to their indiscriminate use without a thorough understanding by the surgeon of the problem which confronts him, of the precise way in which the mechanical apparatus works, of what it may be expected to accomplish, and of any possible dangers or complications attendant upon its use. Moreover, the surgeon should be certain that its use will give him better results than he was able to obtain with the old and familiar methods. The body is a complicated machine and it requires a skilled mechanic to repair it. The surgeon uses his hands and employs tools with which he is familiar and which he knows will accomplish his definite purpose. If he has no efficient tools he may even invent a new one.

Let us, however, beware of adopting new methods too hastily. We recall how a few years ago Sir Arbuthnot Lane taught the open reduction

and plating of all fresh fractures. His dicta in time were accepted by many surgeons in all countries. In the practice of his method not all of these surgeons were as meticulous and skillful as Lane himself, and many cases of osteomyelitis, non-union, and malunion occurred. Then we learned again what we knew before,—that most fractures can be efficiently treated by closed reduction and skillful fixation. A method used successfully by one surgeon may be unsuccessful in the hands of another by reason of some ineptitude and lack of full understanding of the principles involved.

As another illustration, consider the history of the treatment of bone and joint tuberculosis. If we accept as true the conception that tuberculosis is a general disease with a pronounced local manifestation, but with the presence of the tubercle in other places and structures of the body, and that its development is due to a weakening of the resistive processes of the body, then the various methods of the treatment of the local manifestations of the disease in bones and joints will fall into their true perspective. Chronic disease is to be stayed or cured by forces resident in the body itself. Local rest by fixation is but one means of aiding nature to cure the local focus. Whether or not we use prolonged recumbency with traction, or plaster casts, or splints (how few of us have the patience and skill of a Hugh Owen Thomas!) or whether we resort to surgical operation may depend on our own experience and skill. We must, however, recognize that none nor all of these methods of fixation of the diseased joint in themselves and by themselves promise infallible cure. Nature's own forces must be rallied to turn the battle against the invading disease. I decry the indiscriminate employment of biopsy and of surgical operation in the diagnosis and treatment of bone and joint tuberculosis. Present teachings must be viewed in the light of past experience and judged with full knowledge of the principles which underlie the treatment of chronic disease.

Are too many operations performed in the practice of Orthopaedic Surgery? Is there too great a tendency to discard the old and to take up the new or to proclaim as new that which was tried years ago? In recent years operative procedures have been multiplied in our branch of Surgery more rapidly than in any other division of Surgery. Many of our young men believe that they can attain distinction only by the invention of a new operation.

Successful invention can come only after thorough familiarity with the old, its uses and its defects and weaknesses. It seems evident to many of us that surgical procedures are often employed by surgeons who are not thoroughly familiar with the methods of conservative treatment and who are unacquainted with their possibilities. Fusions of the lumbar spine and of the sacro-iliac joints are performed to cure chronic backache when the cause and the origin of the pain are not clearly determined. The result is that many of these operations have not relieved the pain for which they were performed. No operation should be done except for definite

and logical reasons, unless it should be an experimental procedure done as a last resort.

Some operations are performed which do not offer sufficient restoration of function to justify the operative risk. A moderate shortening of an extremity as the result of infantile paralysis may not in itself constitute a severe handicap to the patient. The amount of functional improvement to be secured by leg-lengthening may not balance the surgical risks attendant upon it. It is a primary principle of surgery that no operation should be undertaken routinely, but only after careful consideration of all the factors—physical, mental, social, and economic—that enter into the problem. We must not forget that our specialty was founded in the spirit of conservatism.

You are like a youthful army surging forward. I would counsel you to avoid misapplication and waste of energy, to exercise restraint at times, to curb rashness with sound judgment, to strike a fair mean between conservatism and radicalism, to see the truth written on both sides of the shield, to refrain from fads and fancies, to seek the eternal truth beneath the changing surface, to distinguish fountains of living water from the mirage. Study principles rather than methods. A mind that grasps principles will devise its own methods. Read history and reflect upon the experiences of the past that you may perceive those things that have proved their worth through the years and the centuries and be enabled to avoid the pitfalls of the present and the future.

# OPPOSITION OF THE THUMB *

BY STERLING BUNNELL, M.D., SAN FRANCISCO, CALIFORNIA

A great asset to man is the opposable thumb. The hand so useful to all and the livelihood of the manual worker owes much of its efficiency to this pincer action of the thumb.

Opposable digits are not new in nature. Most birds have them. The digits of the African chameleon directly oppose each other around a branch and as far back as the crustaceans there are opposing claws of crabs and lobsters.

In mammals the opposable thumb is found only in the primates and starts with the lowest forms of them, the lemurs. The more arboreal is the monkey, like the gibbon, and the more developed its prehensile tail, as in the western hemisphere, the smaller and less opposable is its thumb, so the spider monkey is even thumbless. A hand without opposition of the thumb has been called "ape hand", but this is an injustice to the apes as in their hands opposition is well developed and it is even more so in their great toes. In man locomotion has been confined to the feet, leaving the hands free to develop handiwork. The pollex has thus become more opposable and the hallux has lost its power of opposition.

## DEFINITION AND DESCRIPTION

The term "opposition" is from the Latin "*oppositio*" meaning opposite. It implies opposite and far apart like the opposite points in a circle. In astronomy when two heavenly bodies are 180 degrees apart they are said to be in opposition.

The thumb to be in true opposition must not only be opposite the fingers and far forward from them, but it must also be by rotation diametrically opposite to them,—that is, with the pulp of the thumb facing that of the fingers and with the thumb nail parallel to the palm or volar surface of the fingers. Also, in the motion of flexion and extension, the thumb and the opposing digits should move in exactly opposite directions to each other.

Merely placing the thumb into apposition—that is, in contact with the fingers—or drawing it into the palm is not opposition, nor is it when the thumb fails to rotate and its nail is still at a right angle to the palm.

## RANGE OF MOTION OF THE THUMB

Normally the thumb can touch the palm in its distal and radial margins, as well as all of the fingers over most of their surfaces, although this is increasingly less possible on their dorsal and ulnar aspects as the thumb reaches from the index to the little finger. The thumb can also

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 20, 1938.

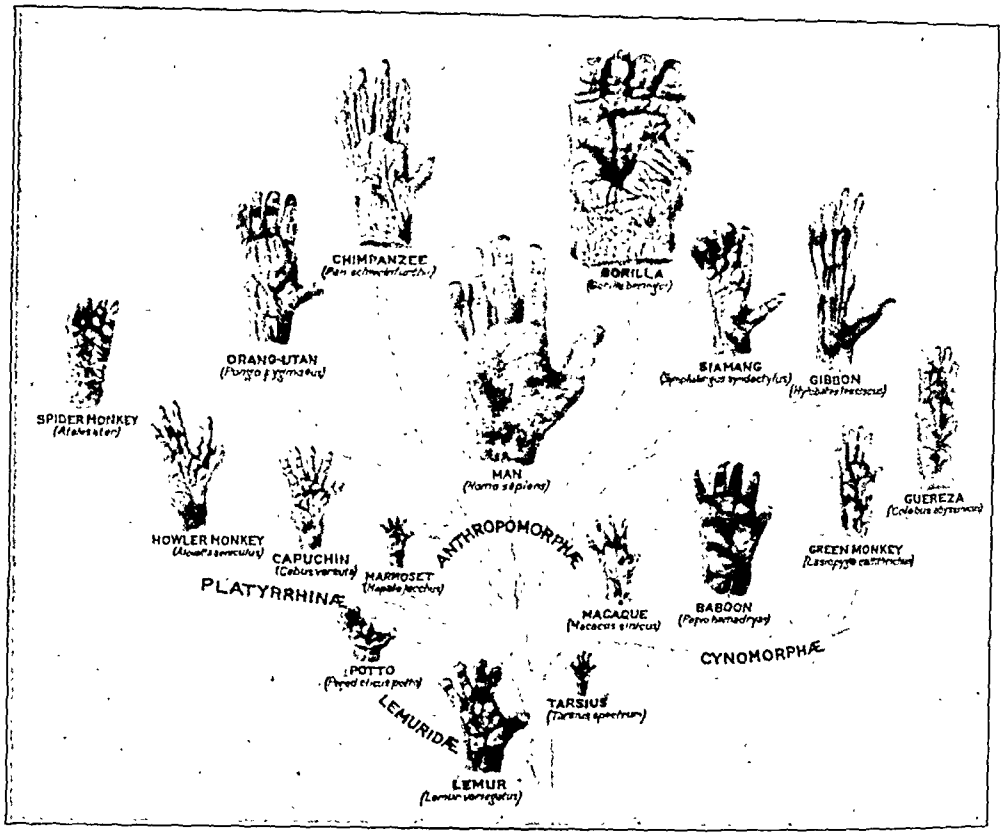



FIG. 1-A

Hands of man and monkeys. Those with the most opposable thumbs are, in order: man, gorilla, baboon, chimpanzee, and orangutan. The more ground dwelling is the monkey, the better developed is the opposable thumb; the more arboreal, the less thumb it has. The more prehensile is the tail, as in new-world monkeys, the less use the animal has for a thumb, until the spider monkey has none at all. (*Courtesy of the American Museum of Natural History, New York, N. Y.*)

pass backward over the radial border of the palm to reach the plane of the dorsum of the hand. From here it can abduct from the hand to about a right angle and then sweep forward from the hand in a semicircle until it touches the base of the little finger. Let us observe the thumb in its excursion through this forward arc. At the start, the thumb and thenar eminence form a cone protruding laterally from the hand. When midway in the path of the semicircle, this cone projects forward from the hand, and the thenar crease is folded to a right angle. If we watch the thumb again through this arc, we will see that at the start the nail is at a right angle to the palm, and the thumb bones are in a straight line as seen from behind. In traversing the semicircle these relations are maintained and a certain strain is felt in the thenar eminence until, as the first third is completed, the strain leaves, the nail starts to rotate in pronation, and the proximal phalanx angulates radially on the metacarpal. As the change occurs, the muscles in the radial half of the thenar eminence conspicuously spring into action and continue the motion. The strain occurs when the adductors are fully stretched by the long extensors of the thumb. The adductors insert on the ulnar side of the proximal phalanx and, when under tension, tend to supinate, but are opposed by the muscles attached to

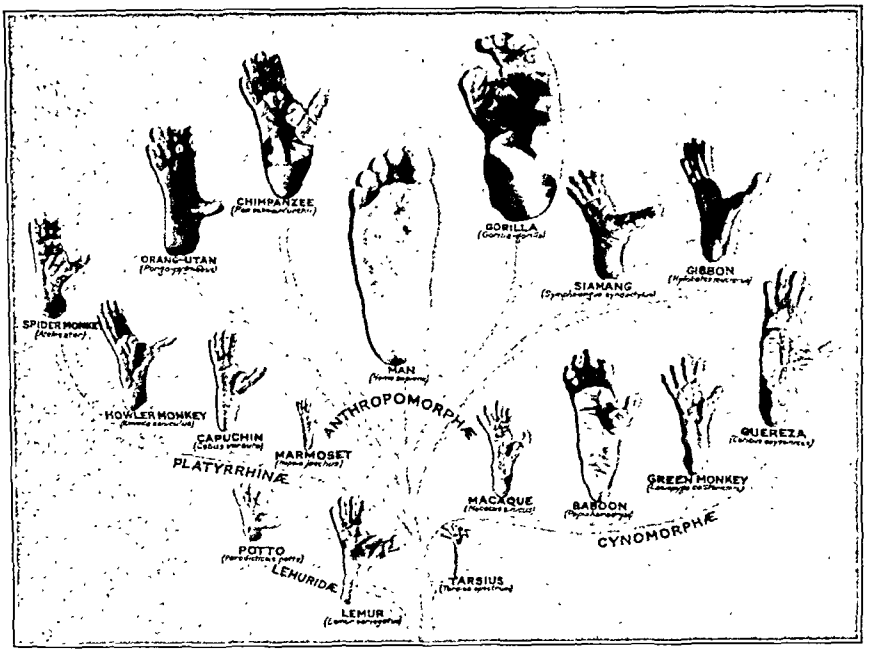



FIG. 1-B

Feet of man and monkeys. In man the feet are used entirely for locomotion, so that the hallux has entirely lost the power of opposition and the pollex has developed it. All monkeys have an opposable hallux far better developed, with the exception of the gorilla and the baboon, than is the pollex. (*Courtesy of the American Museum of Natural History, New York, N. Y.*)

the radial side of the phalanx, principally the outer head of the short flexor. The latter pronates and, after pronation is started, also angulates the phalanx radially. The strain is relieved just as the adductors are relaxed and the short flexors have their way. Throughout the arc the long extensors maintain the necessary stabilization in extension of the three joints of the thumb.

The motion of opposition takes place in the intercarpal, carpometacarpal, and metacarpophalangeal joints. This motion is of two types —angulatory and rotary—and all three joints contribute to each. The carpometacarpal joint furnishes most of the angulatory motion and the metacarpophalangeal joint most of the pronatory motion. The sum of the angulatory movement in opposition is shown in the distal segment of the thumb which angulates through an arc of about 120 degrees, and the sum of the pronatory movement is shown in the plane of the thumb nail which rotates 90 degrees from a position at a right angle to the palm to one parallel with it. In Figures 2-A through 3-B toothpicks are attached to the skin to show better the movements in each segment of the thumb.

The intercarpal movement increases the carpal arch and takes place by the movement of the greater multangular on the navicular and the lesser multangular and by the movement of the latter two in turn on the capitate. This is readily demonstrated by the inability to oppose the




FIG. 7

Case 2. Preoperative spine-marker roentgenogram, with patient in wedging jacket.

With the wrist dorsiflexed and the thumb in opposition, the cleft open for grasp between the thumb and the palm is then in direct line with the forearm as it should be. Opposition aids in forming a circle with the thumb and index finger and an ellipse with the thumb and little finger.

The degree of opposition may be expressed by the distance which the pulp of the thumb reaches in front of the base of the long finger and also by the pronatory angle or the plane the nail makes with the palm as compared in each instance to these measurements in the normal hand. Thus, opposition in a hand may be expressed as one inch and 45 degrees of angle, compared with three inches and an angle of zero, which are the similar measurements taken for comparison in the other or normal hand.

## CAUSES OF LOSS OF OPPOSITION

Loss of opposition results from loss of nerve function to the muscles of the radial half of the thenar eminence, or loss of these muscles themselves, or it may be due to cicatricial contracture from infection which approximates the first two metacarpals, to adhesions which hold back the tendon of the extensor pollicis longus, or to flat-hand from faulty splinting or from ankylosis of the intercarpal and carpometacarpal joints.

## METHODS OF RESTORING OPPOSITION

Opposition may often be restored, depending on its cause, by nerve suture, by excision of the cicatrix binding the first and second metacarpals or of adhesions of the extensor pollicis longus tendon, or by wedge osteotomy in case of ankylosis of the carpus. In eleven cases the author has sutured the motor thenar branch of the median nerve to restore opposition. The motion returned in about thirteen months. In the writer's series of eighty-three repairs of the median nerve by suture, opposition has been restored in 66 per cent.

When the nerve or thenar muscles are irreparable and the mobilizing operations mentioned have been done if necessary, then tenoplasty by

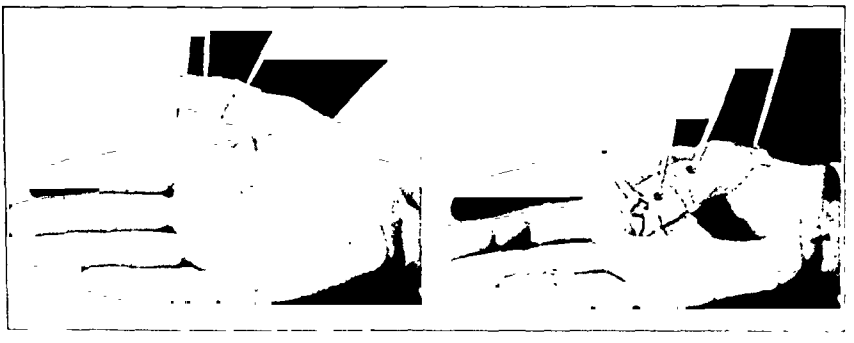


FIG. 3-A FIG. 3-B

Views from the front with the thumb at the side of the hand and in full opposition. Note the degree of pronation of the segments of the thumb made graphic by toothpicks. The nail rotates through 90 degrees. The greatest pronation occurs at the metacarpophalangeal joint.



FIG. 2-A FIG. 2-B

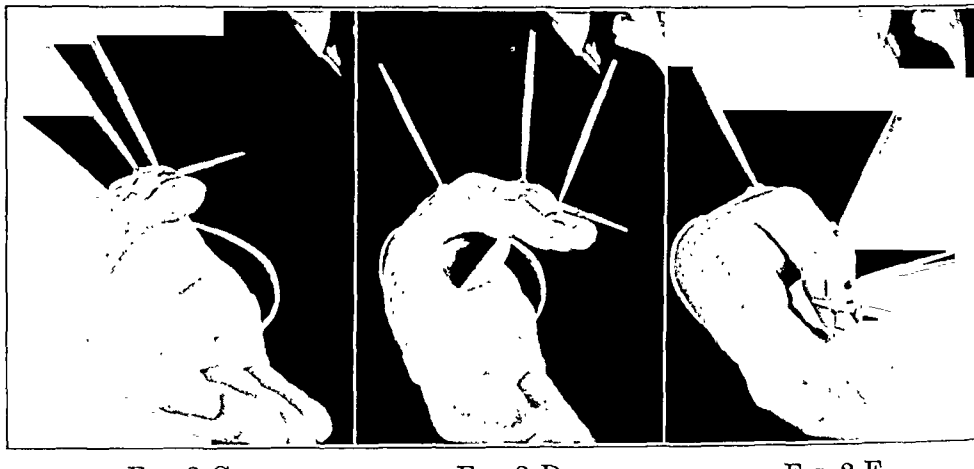


FIG. 2-C FIG. 2-D FIG. 2-E

The successive positions assumed by the thumb in transcribing its normal forward arc of opposition. The toothpicks—one placed crosswise and parallel with the nail and three each vertical to a separate segment of the thumb—are to show more graphicly the angulatory and pronatory thumb movements.

Fig. 2-A: The thumb starts at the side of the hand. The nail is at a right angle with the palm, and the vertical toothpicks are in line with each other.

Fig. 2-B: After the first third of the arc has been traversed, the thumb commences to pronate.

Fig. 2-C: The greatest pronation is between Figs. 2-B and 2-C.

Fig. 2-D: Position of full opposition with the thumb well forward from and opposite the base of the long finger, angulated toward the ulna, and with the nail parallel with the palm. Note the degree of pronation shown in the relative positions of all four toothpicks.

Fig. 2-E: The thumb, now past the position of opposition, is completing its arc and approaching the base of the little finger.

thumb when the carpal arch is prevented from arching. The arching is produced largely by contraction of the thenar muscles which are attached to the transverse carpal ligament. The palmaris longus aids in this. The metacarpal is angulated and pronated on a saddle joint largely by the opponens pollicis aided somewhat by the abductor pollicis longus and the outer head of the flexor pollicis brevis. The proximal phalanx is angulated and pronated mostly by the outer head of the flexor pollicis brevis acting on a ball-and-socket joint.

The main antagonist to opposition is the extensor pollicis longus although this muscle also aids in the motion by its effect along with the extensor pollicis brevis and the abductor pollicis longus in stabilizing the joints of the thumb in extension.

tendon grafting will restore very good opposition if the following two major principles are adhered to.

### TWO ESSENTIAL PRINCIPLES OF TENOPLASTY

The tendon from its insertion in the thumb should pass subcutaneously in the direction of the pisiform bone, so that it will pull the thumb in the correct direction, and the insertion of the tendon should be on the dorso-ulnar aspect of the base of the proximal phalanx of the thumb, so as to restore the pronatory component.

To make the tendon pull toward the pisiform bone, either a tendon pulley is constructed there or the tendon is looped around the distal part of the tendon of the flexor carpi ulnaris. There will then be a similar arrangement to that found anatomically in the omohyoid or the tensor veli palatini muscles.

The first case in which the author used these principles was reported in *Surgery, Gynecology and Obstetrics* in September 1924. His series of forty-six cases has convinced him of the correctness of these principles. Many other methods have been reported by the use of which excellent results have been claimed. From the illustrations in these reports, however, it is evident that the conception of true opposition was not as expressed here. No operation where the tendon passes under the transverse carpal ligament can possibly produce true opposition, as the tendon does not pull in the right direction. It merely pulls the thumb into the palm and not out forward from it.* Also, if a

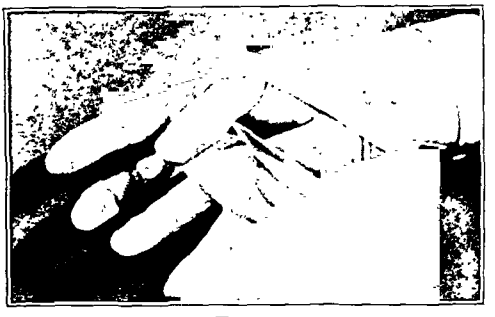


FIG. 5

A splint of adhesive plaster to hold the thumb in position of opposition. A small pad protects the skin. The resultant of pull by the two arms of adhesive is in the direction of the pisiform bone. This splint is useful in protecting paralyzed thenar muscles and newly placed tendons and in bending stiffened joints into this functionating position, including increasing the carpal arch.



FIG. 6-A

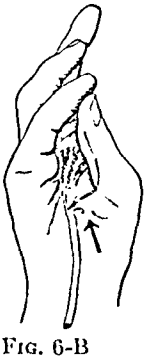


FIG. 6-B

Miss S. P. Restoration of opposition of the thumb by suture of the tiny motor thenar branch of the median nerve. In this case the nerve was severed, as shown in Fig. 6-B, by surgical incision for drainage of the thenar space, which resulted in atrophy of the muscles and loss of opposition. The photograph was taken thirteen months later and shows the well-restored thenar eminence and restoration of ability to oppose the thumb.

* In some cases of poliomyelitis, as Ober has suggested, the transverse carpal ligament is so lax that a tendon passed under it might pull the thumb toward the pisiform bone.

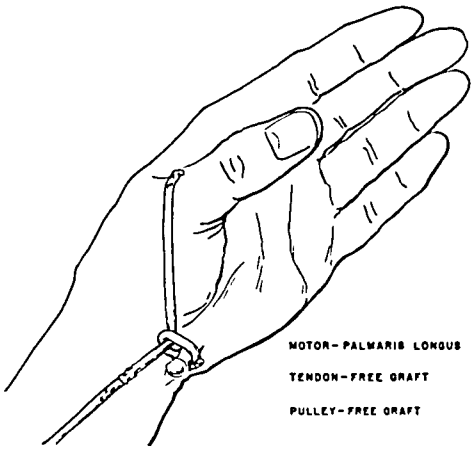



FIG. 4-A

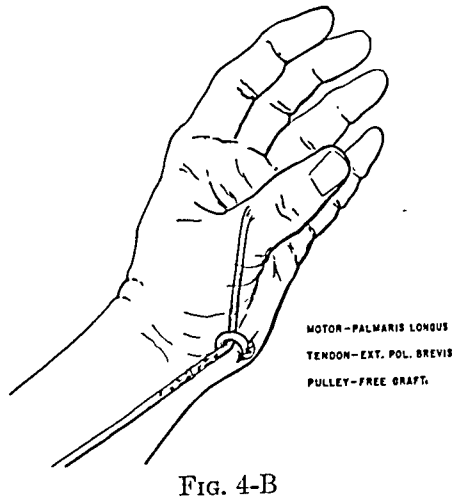



FIG. 4-B

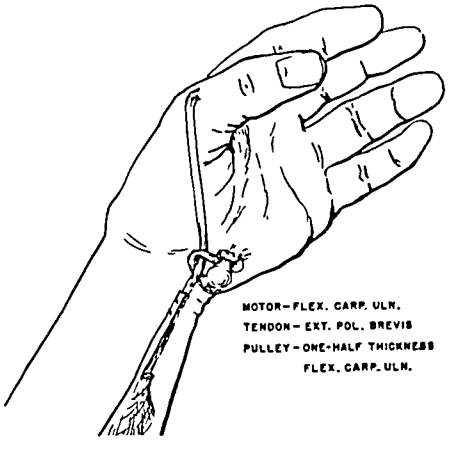



FIG. 4-C

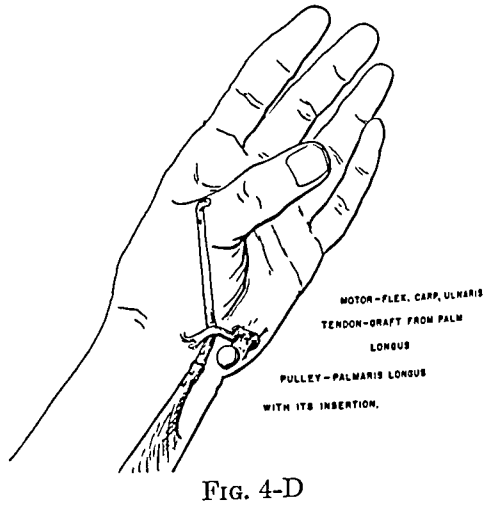



FIG. 4-D

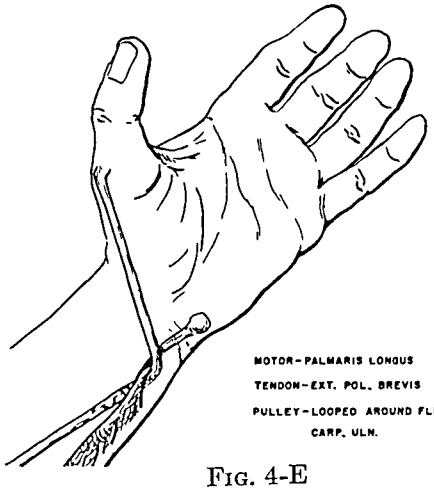



FIG. 4-E

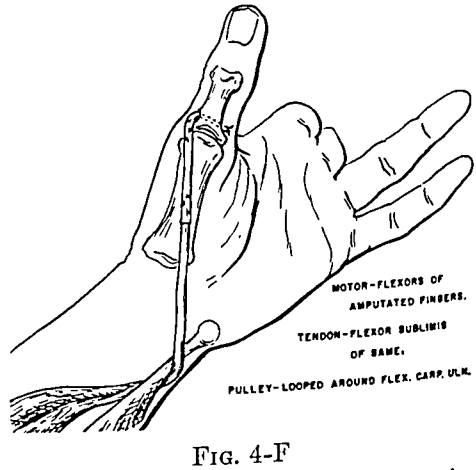



FIG. 4-F

Operation advised to restore ability to oppose the thumb. The two essential principles are: (1) The tendon should pull in the right direction,—namely, subcutaneously diagonally across the thenar eminence toward the pisiform bone to angulate the thumb forward and toward the ulna; (2) the insertion of this tendon should be into the dorso-ulnar aspect of the base of the proximal phalanx, so as to pronate the thumb. Then one may use whatever seems best in the individual case for motor power, tendon, and pulley. These drawings illustrate what muscle and tendon material may be used and ways of constructing the pulley.

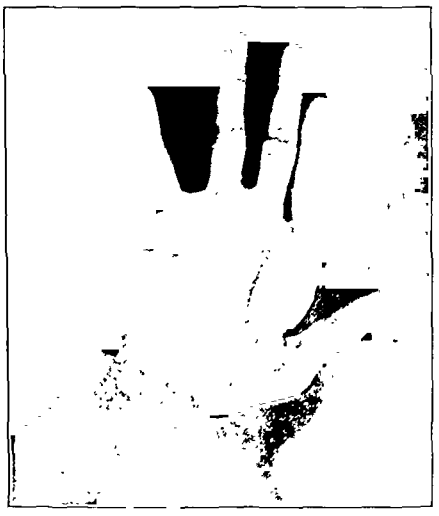


FIG. 8-A



FIG. 8-B

Mr. W. W. Extensive laceration of the hand and wrist eighteen months previously in which the median and ulnar nerves and several tendons were severed.

Fig. 8-A: Complete thenar atrophy and loss of adduction and opposition of the thumb and loss of abduction of the index finger.

Fig. 8-B: Extensive repair of nerves and tendons was done. Without waiting for the nerves to regenerate, the tendon of the extensor indicis proprius was sutured to that of the first interosseus muscle with restoration of abduction of the index finger. A pulley operation was then done on the thumb, in which the flexor carpi ulnaris was used as the motor power and a slip from it was used to construct the pulley. The tendon of the extensor pollicis brevis was withdrawn from the arm and transferred subcutaneously across the thenar eminence through the pulley and sutured to the flexor carpi ulnaris. In the photograph, taken only two months later, the tendon can be seen drawing the thumb two inches in front of the base of the index finger.

Lyle employed the same method, but, in addition, combined it with Steindler's operation on the flexor pollicis longus tendon.

The following are methods using the flexor pollicis longus tendon and also keeping the tendon beneath the transverse carpal ligament:

Steindler split the distal end of the flexor pollicis longus tendon in two and detached the radial half from its insertion, passed it around the radial side of the thumb, and reinserted it at the back of the base of the proximal phalanx.

Silfverskiöld risked the use of the whole flexor tendon of the thumb, transplanted it around the radial side of the thumb, and inserted it at the base of the proximal phalanx.

Whitehurch severed the flexor pollicis longus tendon, carried it around the radial side of the thumb, and resutured it.

Von Baeyer freed the insertion of the flexor pollicis longus, passed it around the radial side of the thumb, and reinserted it at its original insertion.

In the following methods the extensor tendons are used:

Jahn passed the extensor tendon of the third digit around the ulnar border to the volar side of the hand and inserted it into the first metacarpal. He repaired the defect with a free fascial transplant.



FIG. 7-A



FIG. 7-B

Dr. E. S. Restoration of opposition of the thumb by suture of the median nerve at the wrist.

Fig. 7-A: From laceration at the wrist, both median and ulnar nerves and several tendons were severed, resulting in claw-hand with atrophy of the thenar muscles and complete loss of opposition and adduction of the thumb.

Fig. 7-B: Two years later function of the intrinsic muscles had been restored by suture of the median and ulnar nerves. The thenar eminence and other intrinsic muscles, as well as the ability to oppose the thumb, had been restored so that the patient was able to resume the practice of dentistry.

tendon is used for opposition, it should be for that function alone and should not have two insertions, each for a different function. Otherwise there will not be free and independent action in each of the two functions. If a flexor is used, the thumb cannot be flexed without opposing. The muscle transferred should be adequate in strength and its original function, if important, should not be sacrificed.

## OTHER METHODS REPORTED

With these principles in mind, the author wishes to mention briefly the methods previously reported.

The first group represents methods in which the tendon is passed under the transverse carpal ligament:

Krukenberg split the flexor digitorum sublimis tendon of the long finger and inserted it in the radial half of the first metacarpal.

Roeren did the same with the flexor digitorum sublimis tendon of the ring finger.

Ney used the tendon of the extensor pollicis brevis detached above, and, after passing it under the transverse carpal ligament, joined it to the tendon either of the palmaris longus or of the flexor carpi radialis.

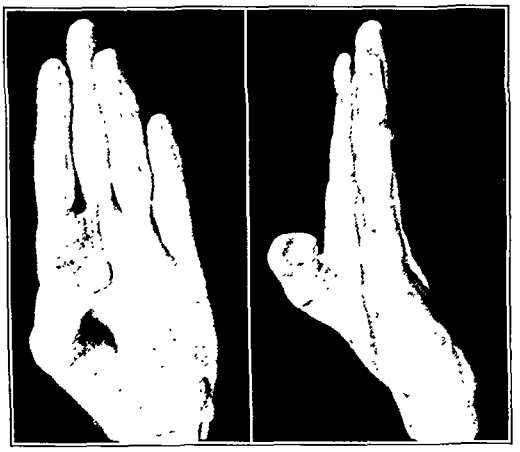


FIG. 10-A FIG. 10-B

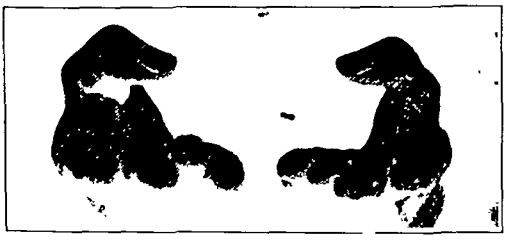


FIG. 10-C

FIG. 10

Mr. P. C. A burn from a bottling machine destroyed the thenar eminence. This was covered by a pedicle skin graft.

The ability to oppose the thumb was restored by a tendon-transfer pulley operation. The tendon of the extensor pollicis brevis was detached at its muscle, withdrawn through an incision at its insertion, and then passed subcutaneously across the thenar eminence toward the pisiform bone. The tendon of the palmaris longus was detached at its insertion, looped about the tendon of the flexor carpi ulnaris for a pulley, and then sutured to the tendon of the extensor pollicis brevis.

Figs. 10-A and 10-B: Good opposition restored. The tendon pulling beneath the skin is apparent.

Fig. 10-C: Showing loss of the thenar eminence.

FIG. 11

Fig. 11-A: Mr. A. H. The median nerve had been severed at the wrist and was sutured three years previously, but without return of the thenar eminence or ability to oppose the thumb.

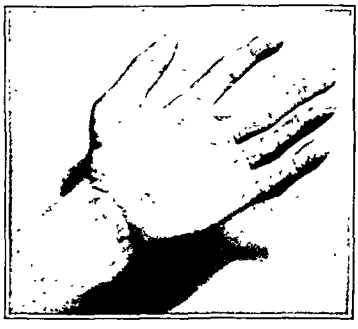


FIG. 11-A

Fig. 11-B: Mr. A. H. A tendon-transfer pulley operation promptly restored ability to oppose the thumb as shown in the hand with the atrophied thenar eminence and the sleeve rolled up.

The flexor carpi ulnaris tendon was split in two near its insertion. One half was used to make a pulley and the other was detached at its insertion and prolonged by a free graft from the tendon of the palmaris longus. This was passed through the pulley, across the thenar eminence subcutaneously, over the dorsum of the proximal joint of the thumb, and attached by a drill hole to the base of the proximal phalanx at its dorso-ulnar aspect.

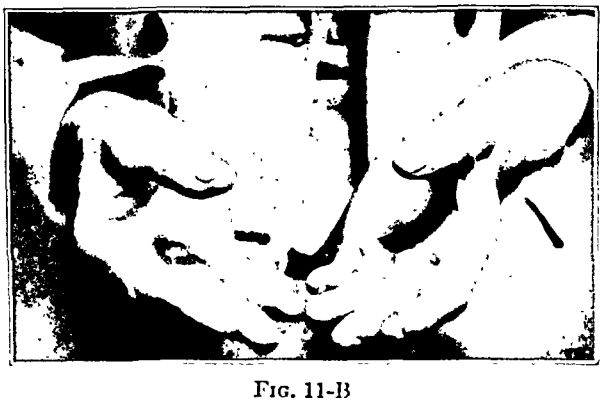


FIG. 11-B

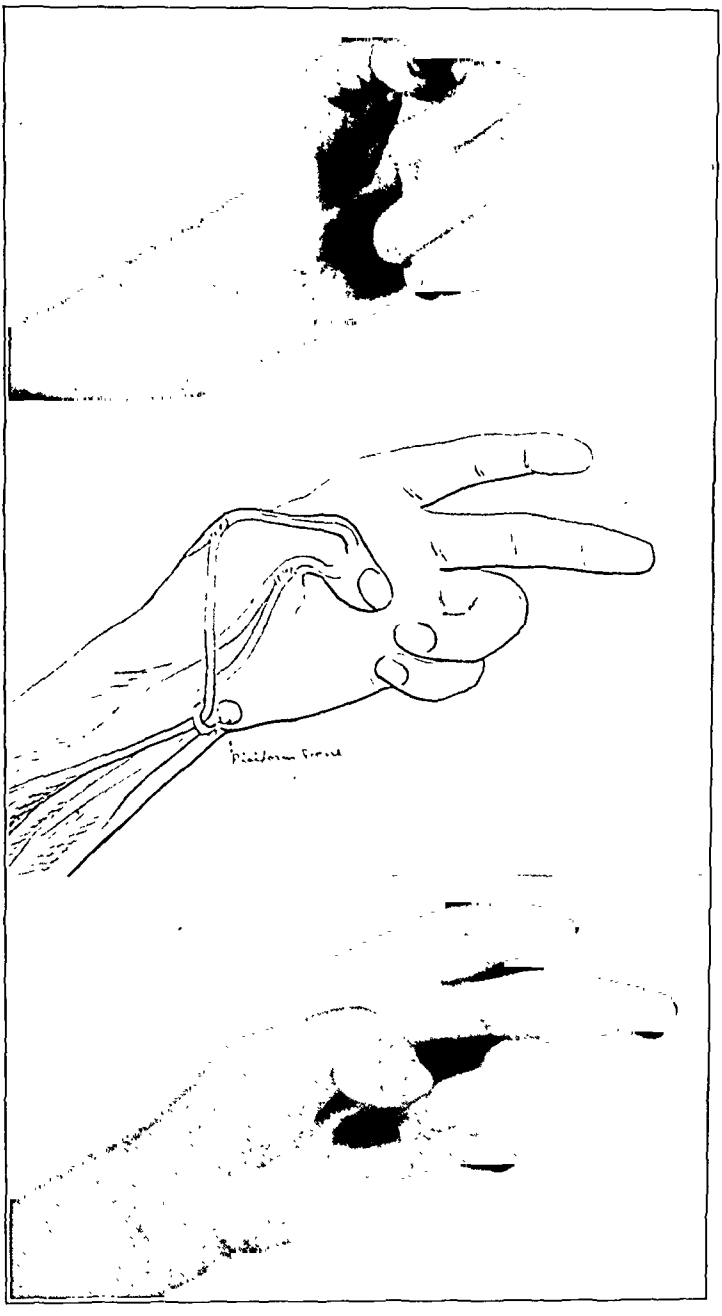


FIG. 9

FIG. 9

Miss M. V. Following poliomyelitis at the age of four, the thenar muscles atrophied and the patient could not oppose the thumb at all nor could she flex it. Also the extensor pollicis longus was too weak. The flexor digitorum sublimis of the ring finger was transferred to the flexor pollicis longus to furnish flexion. For opposition the palmaris longus, together with its extension, the palmar fascia, was passed through a pulley at the pisiform bone made from an extensor of the toe, and passed on subcutaneously to be attached to the tendon of the extensor pollicis longus. This restored ability both to extend and to oppose the thumb.

*Upper:* Limit of opposition preoperatively.

*Middle:* Tendon transfers.

*Lower:* Function of thumb, including restoration of opposition.

Cook's operation, as described by Taylor, consisted of passing one of the extensor tendons of the little finger around the wrist subcutaneously and inserting it into the first metacarpal.

Other miscellaneous methods are as follows:

Huber and Nicolaysen used the abductor of the fifth digit and fastened it to the first metacarpal.

Camitz inserted the tendon of the palmaris longus with some of the palmar fascia on the lateral side of the metacarpophalangeal joint of the thumb.

Kortzeborn used a fascial sling to fix the thumb in opposition, did a plastic operation on the palm, and lengthened the extensor tendons.

Spitzy, and also Baldwin, performed an arthrodesis on the carpo-metacarpal joint of the thumb.

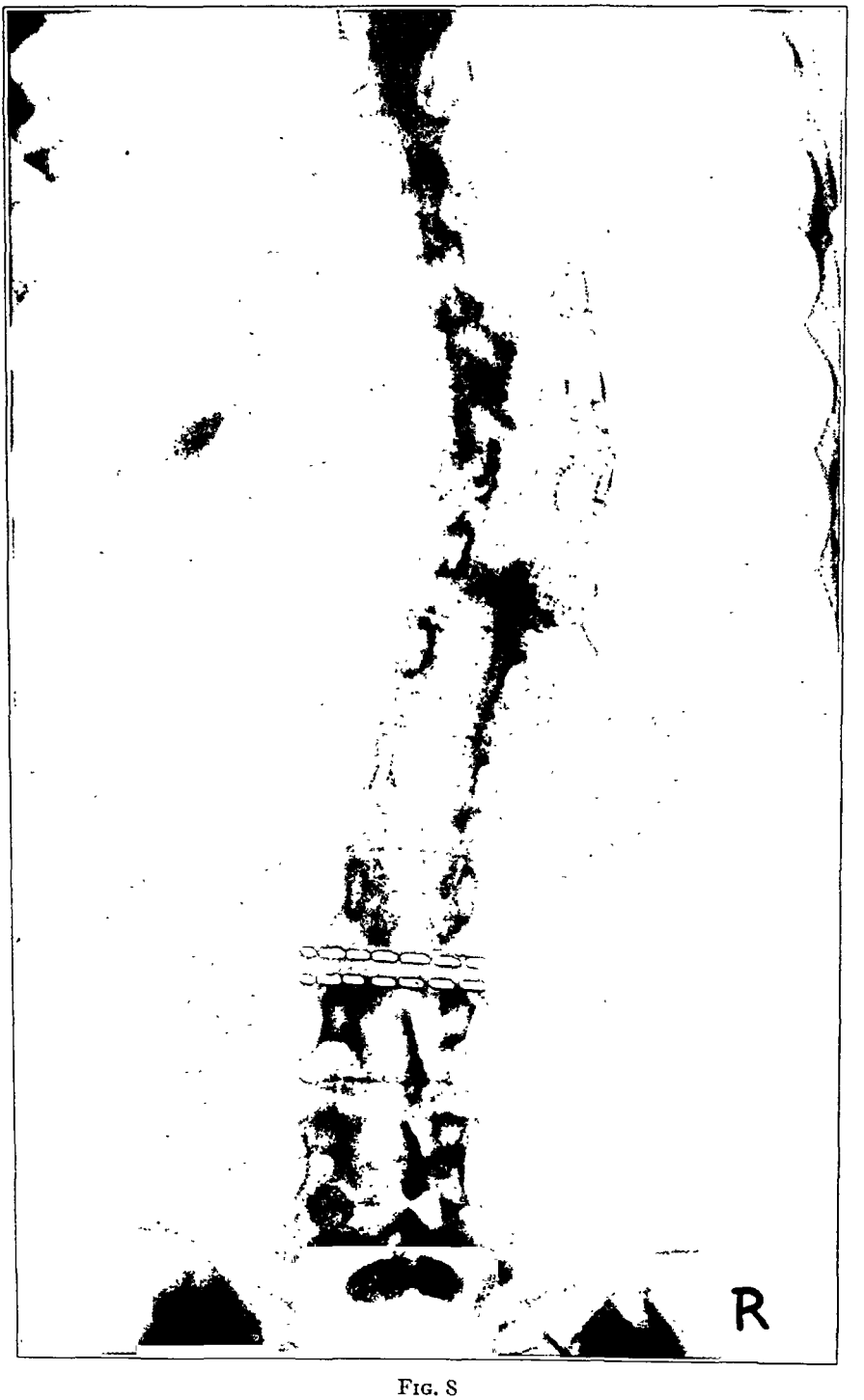



FIG. 8

Case 2. Three and a half years after operation, with patient standing.

Foerster planted a three-centimeter bone graft from the tibia between the first two metacarpals.

### TECHNIQUE OF OPERATION ADVOCATED

If the two main essential principles mentioned are adhered to, one has quite a varied choice in the selection of muscle and tendon and in the construction of the pulley, depending on which are available or advantageous in the particular case of reconstruction. Each hand is a problem in itself, and, as the parts injured differ, so we must adapt our procedure to the available material providing we adhere to these two simple principles,—namely, direction of pull and correct insertion to give pronation.



FIG. 12-A

Any of the following may be available:

For motor power, we may use the flexor carpi ulnaris, the palmaris longus, the flexor digitorum sublimis of the ring finger, or any available long flexor muscle. The extensor muscles



FIG. 12-B

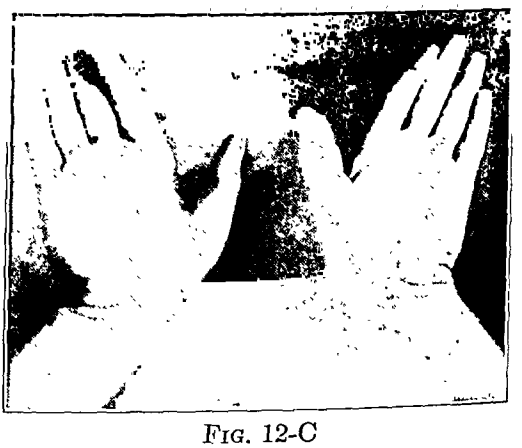


FIG. 12-C

Mr. R. F. A porcelain faucet lacerated the thenar eminence, damaging the motor thenar branch of the median nerve beyond repair and thus paralyzing the abductor and opponens pollicis muscles, so that the patient could not oppose the thumb. The flexor tendon and the two volar nerves of the thumb were also severed. Four months later the flexor pollicis longus tendon was repaired by a free graft from the palmaris longus tendon, and the two sensory nerves were sutured. A tendon-transfer pulley operation was done to restore opposition. The tendon of the extensor pollicis brevis was detached at its muscle, withdrawn near its insertion, and then passed subcutaneously across the thenar eminence. Here it was passed through a pulley made from a free graft of the palmaris longus and was sutured to the tendon of the flexor carpi ulnaris which was detached from its insertion for the purpose.

Fig. 12-A: Showing the ability to oppose the thumb to two inches in front of the base of the ring finger and two and one-half inches in front of that of the long finger.

Fig. 12-B: The pronation and forward position gained.

Fig. 12-C: Atrophy of the thenar eminence. The original function of the flexor carpi ulnaris muscle has not been lost.

are rather weak for this purpose, and their course is long, thus presenting opportunities for the formation of adhesions.

In regard to tendons, the extensor carpi radialis brevis is excellent as it already has the correct insertion, and also will retain its original function

FIG. 13

Mr. T. T. Ability to oppose the thumb was lost by a wide excavation of a dado saw through the thenar eminence, which destroyed beyond repair the muscles and motor thenar branch of the median nerve.

*Ability to oppose the thumb* was regained by a tendon-transfer pulley operation, using the flexor carpi ulnaris muscle for the motor power. The tendon of the extensor pollicis brevis, which had been withdrawn from above, was passed subcutaneously across the thenar emi-



FIG. 13-A



FIG. 13-B

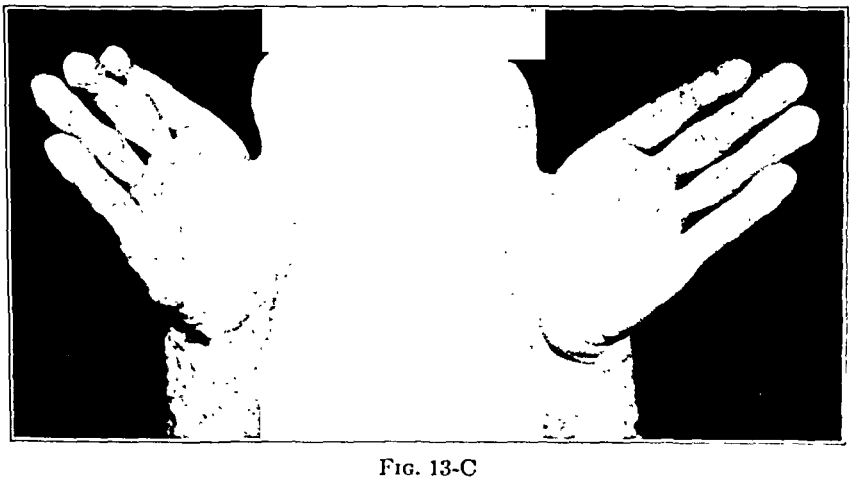


FIG. 13-C

nence and through a pulley at the pisiform bone. This pulley was constructed from a free tendon graft of the palmaris longus and was sutured to the tendon of the flexor carpi ulnaris. The latter was detached from its insertion at the pisiform for the purpose, but did not lose its function as is shown in Fig. 13-C. Opposition of the thumb was restored as shown in Figs. 13-A and 13-B. The atrophy of the thenar eminence shows in all three pictures.

and can be sutured to another tendon just proximal to the pulley at the pisiform bone. Also, the palmaris longus can be prolonged sufficiently by using its prolongation, the palmar fascia, or any tendon desired can be pieced out by a free tendon graft either from the palmaris longus tendon or from any other tendon that may be available.

For the construction of a pulley at the pisiform bone, a free tendon graft either from the palmaris longus or from any other available tendon can be looped through the short muscle and tendon attachment to the pisiform bone and sutured to itself, so that it forms a circle two centimeters in diameter. The sutured junction is then slipped around until it is within the muscle.

Another method of making a pulley is to use one-half the thickness of the flexor carpi ulnaris tendon, severing one of the halves high and suturing this free end to the ligament of the pisiform bone to complete the loop.

Similarly, the tendon of the palmaris longus can be severed four centimeters above its insertion and made to act as a loop or pulley by suturing it into the pisiform ligamentous tissue, leaving its original insertion intact.

Instead of constructing a pulley, one can pass the tendon used around the flexor carpi ulnaris tendon and on to its insertion in the phalanx of the thumb. The flexor carpi ulnaris then aids in the opposition.

For the sake of clarity, a few concrete examples of the technique are shown in Figures 4-A through 4-F.

In the reconstruction there may be available some tendons of the long extensors of the toes or opposite the palmaris longus. With a free graft of one of these, a pulley can be made at the pisiform bone. The tendon of the palmaris longus is detached at its insertion and prolonged by a free tendon graft, passed through the pulley and then subcutaneously across the thenar eminence over the head of the metacarpal to be inserted through a drill hole in the dorso-ulnar aspect of the base of the proximal phalanx. Another method is to detach the tendon of the extensor carpi radialis brevis high, draw it out at its insertion, and then pass it subcutaneously across the thenar eminence to the pisiform bone. Here it is passed through the pulley and then sutured to the distal end of the tendon of the flexor carpi ulnaris. The flexor carpi ulnaris muscle is quite strong, and, if it is used to give the thumb opposition, its normal function of ulnar palmar flexion is not lost. Also, if the extensor pollicis brevis is used, the function of extension of the thumb is not lost.

## CONCLUSION

The opposable thumb is valuable to man. A thumb in true opposition is not only opposite the fingers, but it is far forward from them and is rotated so that the pulp faces that of the fingers and the nail parallels the palm. Any tenoplasty to produce this must adhere to two essential principles. The tendon must pull subcutaneously in the right direction toward the pisiform bone and it must be inserted in the dorso-ulnar aspect

of the base of the proximal phalanx of the thumb to give pronation. This may be accomplished by using any of various muscles for motor power, and for the tendon either the extensor pollicis brevis tendon or any one of various tendons prolonged by tendon grafts. The tendon used is made to pull in the right direction either by passing it through a tendon pulley constructed at the pisiform bone or by passing it around the tendon of the flexor carpi ulnaris.

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# DISEASES OF THE APOPHYSEAL (INTERVERTEBRAL) ARTICULATIONS

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This study has its origin in the commonplace observation that recurrent or persistent pain and stiffness in the spine are not always associated with demonstrable anatomical changes, and that well-marked spinal lesions may be found in the absence of any clinical symptoms. This discrepancy is not fully explained by the variable condition of the vertebral bodies, intervertebral discs, and spinal ligaments, or by disturbances in the functional correlation between the muscles and bones of the back.

Little is known in this connection about the behavior of the apophyseal joints. There are investigations on the pathogenesis and morbid anatomy of certain inflammatory and degenerative diseases (Beneke; Burckhardt; Eaton; Fischer and Vontz; Fraenkel; Güntz; Klinge; Schmorl and Junghanns; Shore; Simmonds; and Sivén); on their relations to systemic and traumatic affections of the spine (Beneke; Fraenkel; Knaggs; Lang; Lange; Schmorl and Junghanns; and H. Turner); on the roentgenographic technique involved (Dittmar; Ghormley and Kirklin; Jordan; and Lange); and on the correlation of roentgenological and anatomical findings (Bakke; Forestier, Coliez, and Robert; Robert and Forestier; Schmorl and Junghanns); but systematic studies on the interrelations between the clinical conditions and the underlying anatomical changes have not yet been published.

Significant incipient and transitional phases are met with on autopsy only very exceptionally; thus there is as yet no uniformity in interpretation of pathological findings in spondylarthritis. Clinically, affections of these articulations do not cause very distinctive local manifestations. Roentgenologically, some of the pathological structures involved are too radiolucent to produce definite shadows; [13, 26, 39] and the inaccessible position of the joints, their complicated structure, and their variable relation to the vertebral bodies render the articulations almost invisible on "routine" roentgenograms. They are, however, demonstrable by methods more recently developed, but, since the elaborate technique involved has not yet been generally adopted as a part of standard examinations of the spine, the observations are still too limited in number to allow consistent interpretation.

It is for these various reasons that the author's own findings are here submitted. They are the result of 1,000 roentgenographic examinations of the spine; of clinical and roentgenographic observations on 147 patients with various lesions of the apophyseal joints, many of whom have been reexamined at intervals during periods of from one to three years; and of

studies on the differences between anatomical and roentgenological findings. Special attention has been given to the following questions:

1. Can the diseases be classified anatomically or etiologically?
2. Are there demonstrable interrelations between certain clinical and distinct anatomical findings?
3. What are the relations between diseases of the apophyseal joints and affections of other elements of the spine?
4. Can treatment be directed by the results of such diagnostic evaluation?

## ROENTGENOGRAPHIC ASPECT

The apophyseal articulations are the only true joints of the spine. Considered both as units and as a system of interlinked joints, they are fairly well separated from the anterior weight-bearing section of the column which is formed by the "axial elements",—that is, vertebral bodies, intervertebral discs, and longitudinal ligaments. Unlike the cancellous vertebral bodies, the articular processes, as parts of the arches, consist of compact bone.

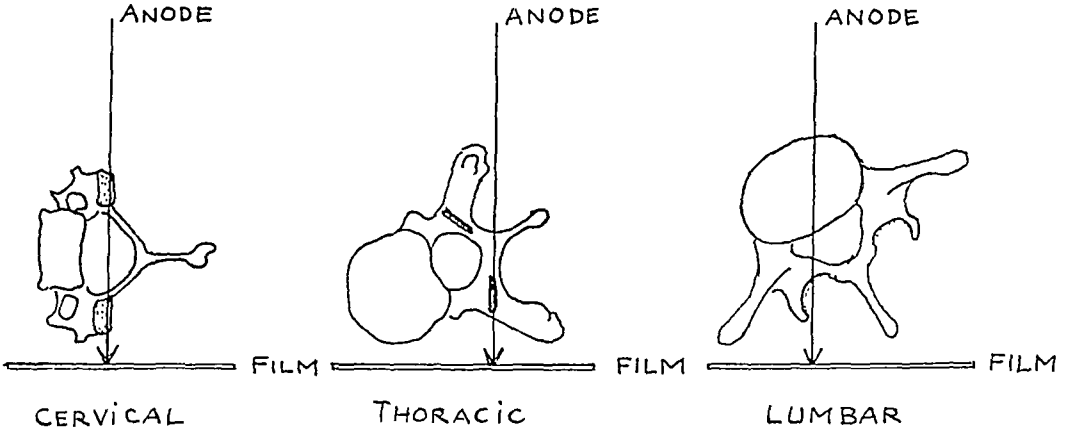



FIG. 1

Positions for roentgenographic demonstration of the *left* apophyseal articulations. The arrows indicate the direction of the central ray.

The superior and inferior articular processes are the parts of one bone which, having no anatomical designation, is here called "articular segment"; its center, from which the articular processes originate, is the interarticular portion. Each articular process has a facet covered by cartilage; the joint space between them normally varies in width and amount of synovia.[18] The anterior portion of the capsule forms the posterior border of the intervertebral foramen through which the corresponding spinal nerves pass; its posterior part is covered by the ligamentum flavum. The other periarticular ligaments are of little importance pathologically.

The articular surfaces vary in position and shape in the several regions of the column. The relative positions of the patient, the tube, and the

film are shown in Figure 1. The roentgenographic technique is discussed in a separate report.

On physical examination in each case, the mobility of the spine was studied; also the type of pain possibly elicited by palpation and percussion, or by certain active and passive movements of the spine and limbs, especially backward stretching of the spine. A majority of patients had complete clinical and laboratory examinations in the hospital. A detailed history was obtained in all cases.

## PATHOLOGICAL CHANGES

The apophyseal joints, being covered by thick layers of soft tissues, do not show, when diseased, such conspicuous signs as swelling or redness. The type of pain in the spine and its relation to posture and to certain movements may often give suggestions as to the underlying morbid condition;[34] but, since the diagnosis in most cases depends eventually upon the roentgenological findings, these are here taken as landmarks. The American terminology is followed in this report: "atrophic arthritis" corresponds to the British "rheumatoid", to the German "primary" or "*Infekt-arthritis*", and to the French "*arthrite*"; "hypertrophic arthritis", to "osteo-arthritis", to "*Arthrosis*" or "*Osteo-arthropathie*", and to "*arthrose*", respectively.

These anatomical designations are here used because, being the simplest, they afford the most satisfactory basis for discussion, although obviously the purely anatomical view cannot take into account other aspects of the matter.



FIG. 2

Acute spondylarthritis. A defined soft shadow obscures the third cervical apophyseal joint space (arrow). No other changes are present.

The patient was a male, twenty-nine years old. He complained of pain in the neck, which radiated to the left elbow.

### *Atrophic Spondylarthritis*

Atrophic arthritis, characterized by an inflammation affecting primarily the synovial membranes, occurs in the apophyseal joints in one of two main types,—namely, acute or chronic. The acute form has been found to be a strictly localized condition; the chronic develops into a distinctly systemic disease in typical cases, but may in others become arrested and then remain more or less localized.

#### *Acute*

Seven cases have been observed,—two males and five females; the youngest patient was nineteen years of age and the oldest thirty-seven.

Following an acute respiratory infection, dull pain, confined to a



FIG. 3

Acute spondylarthritis. The fourth and fifth cervical apophyseal joint spaces are obscured (black arrows), and there is slight generalized rarefaction of the corresponding articular processes (white arrows). Compare with the normal upper joint space and bones.

The patient, a female, aged twenty-eight years, had a low-grade fever, severe pain in the neck with marked rigidity caused by muscle tension, and severe pain in the right arm with complete disability.

small section of the spine, developed "over-night". In five cases, the cervical spine was affected; in two, the sacrolumbar region. Pressure upon the region involved elicited severe pain radiating into the arm or along the course of the sciatic nerve. A sensation of stiffness in the painful area was complained of. On examination, increased muscle tension in this area was evident, but the mobility of the spine was found free. No other joints were simultaneously affected.

Roentgenologically, no changes were found in two instances. In three cases, a homogeneous hazy shadow, extending slightly beyond the margins of the articular processes, obscured the apophyseal-joint space of the painful cervical articulation (Fig. 2). In one of these cases, both the bone structure and the outlines of the corresponding articular processes were normal. In the two other patients, the outlines of the facets were indistinct and the bone density of the articular processes was moderately diminished (Fig. 3). In all the cases, the discs and the vertebral bodies were normal. The shadow described corresponds in location and in size to the articular capsule; it is too small and too circumscribed to represent, for example, a thickened muscle. Its disappearance with subsiding clinical symptoms characterizes it as the expression of a transient swelling.

Two patients left the hospital before treatment was attempted. In two other cases, the symptoms subsided entirely within ten days under short-wave treatment over the diseased region. In the fifth case, there was a recurrence after seven weeks. Reexamination revealed chronic tonsillitis with pus in the very large tonsils. Following tonsillectomy, the symptoms subsided and have not recurred (seven months after operation).

In the sixth case, severe pain in the lower back associated with excruciating "sciatica", loss of reflexes, and muscle atrophy in the diseased leg had persisted for eleven months. In this patient, mottled demineralization of the left sacrolumbar articular processes and blurred outlines of the facets were found,[34] but the joint space itself was of normal width. Within forty-eight hours after removal of the inflamed tonsils, this patient was completely cured; at present, nineteen months after tonsillectomy,

he is in perfect health, but the articular processes involved are still a little less dense than on the normal side. In the long duration of the disease, as well as in the marked involvement of bony parts, this case differs in degree from those preceding it.

The condition here discussed is marked by a localized, usually monarticular inflammation in an apophyseal joint. The normal width of the articular spaces indicates that the cartilages remain intact. Accordingly, restoration to normal is still possible. The articular affection was associated with acute respiratory infection and, in two cases of longer duration, with chronic tonsillitis. A causative correlation with this focal infection was made very probable by the immediate and lasting result of tonsillectomy.

None of the patients had symptoms of rheumatic fever; the presence of definite anatomical alterations in the absence of noticeable general symptoms stands in contrast to this polyarticular affection. Nevertheless, rheumatic fever and acute phases of atrophic arthritis may "differ in degree rather than in kind".[36] The condition is best termed "acute spondylarthritis" (*spondylos*=vertebra; *arthron*=joint); since hypertrophic arthritis is never acute, it would seem unnecessary to add "atrophic".

*Chronic*

Chronic atrophic arthritis is characterized by destruction of articular cartilages,—an irreparable lesion, for cartilage cannot be regenerated. Hence the distinction between acute and chronic atrophic spondylarthritis is here not based upon the duration of the clinical symptoms, but is determined by the absence, in the former, of destruction of cartilage.



FIG. 4-A



FIG. 4-B

Chronic atrophic spondylarthritis. The space between the left fifth and sixth cervical articular processes is much narrower (arrow) than the right. Amoebiasis. Case referred to in text.



FIG. 5

Chronic atrophic spondylarthritis. The fifth thoracic apophyseal joint space is narrowed (arrow); the superjacent articular process is thinner and less clearly defined than in the lower normal joints.

The patient, a female, aged thirty-two, complained of pain in the back, which radiated along the intercostal nerve. Rotation to the left was impaired, and rigidity of the thoracic spine was present. There was no fever.

Roentgenologically, therefore, the differentiation is made according to the width (normal or diminished) of the involved joint space. It is obvious that destruction of cartilage narrows the joint space.

At this stage (while still uncomplicated by secondary changes to be discussed later) the disease is rarely observed. The author has seen four cases.

A merchant, forty-two years of age, complained of severe pain in the left portion of the neck, followed after a week by stabbing sensations in the left shoulder, elbow, and hand, and numbness of the left finger tips. These symptoms had begun after a "chill" nine weeks previously. Raising the left hand behind the neck caused pain in the neck and the shoulder. There were no other symptoms except low-grade fever. Clinically, there was very marked persistent tension of the extensors of the left side of the neck. The cervical spine was held stiff and straight; rotation was slightly impaired, and forward bending (both active and passive) was impossible. Percussion of the spinous processes did not elicit any sensation, but pressure upon the fifth and sixth cervical vertebrae, four centimeters to the left of the posterior mid-line, caused moderate pain locally and severe radiation into the left shoulder, with tingling in the finger tips. Roentgenographically, the space between the left fifth and sixth cervical articular processes was narrowed as compared with the right side (Figs. 4-A and 4-B). There was no demineralization of articular processes and no calcification of ligaments. The facets involved were parallel in position. Because endamoeba histolytica was found in the stools, antiamoebic treatment was given, with the result that the temperature became normal and spontaneous pain subsided within four days. Twelve days after the first examination, there was no longer any pain or muscle tension; nevertheless, the mid-cervical spine was rigid, and the involved joint space was as narrow as before.

In two other patients with chronic tonsillitis, pain and rigidity of the section involved were found associated with narrowing of the cervical and lower thoracic articular spaces. No other joints were affected, and there were no "rheumatic" manifestations. In the fourth case, the thoracic articular processes adjacent to the narrowed joint spaces were *slightly* rarefied (Fig. 5). This patient had chronic amoebiasis.

The significance of these findings will be discussed together with those characteristic of ankylopoietic spondylarthritis.

*Ankylopoietic Spondylarthritis*

This is a typical atrophic arthritis (as proved histologically [14, 18, 42]), with a marked tendency toward systemic involvement of all of the apophyseal articulations and demineralization of the vertebral column.

Eleven cases have been observed (nine males and two females). The symptoms varied in intensity according to the stage of the disease and to the extent of the involvement. The patients stated unanimously that pain in various regions of the spine had followed some acute infection. The spinal section involved had become stiff; pain and rigidity had extended gradually to other parts of the spine; and radiating pain into the extremities had accompanied these symptoms at irregular intervals. The clinical aspect is unmistakable: the region involved, and sometimes the whole spine, is perfectly rigid and at the same time straightened; the neck is fixed in a position of forward extension, and there is an angulation at the junction of the thoracic and cervical portions. Movements such as rotation or bending forward are performed by means of other joints,—the patient turns on his feet, and he bends forward by flexing at the hip joints, whereby the spine retains its rodlike straightness. Often the leg cannot be elevated unless bent at the knee joint as in sciatica (Lasègue's sign), but without the sciatic pain. (See Figures 6-A, 6-B, 7-A, and 7-B.)

Roentgenographically, in the early stages, the articular spaces affected are narrowed (Fig. 8-A); simultaneously, the articular processes appear demineralized. The facets remain parallel in position, and the section involved, losing its physiological curve, is straightened. Very soon (within from three to four months) the vertebral bodies also may decalcify, so that all the bone elements of the diseased portion increase in radiolucence (Figs. 8-A and 11-D). In the course of not less



FIG. 6-A



FIG. 6-B

Ankylopoietic spondylarthritis confined, at present, to the lumbar spine.
Fig. 6-A: Maximum degree of forward bending of which the patient is capable.
Fig. 6-B: To reach the floor with the finger tips, the patient is obliged to bend the knees.
The patient, a merchant, aged thirty-nine years, gave a history of pain in the lower back of four years' duration, intermittent sciatica, and gonorrhoea. At present, there is no pain, but rigidity of the lumbar region is present. There is no fever. Lasègue's sign is positive in the absence of any sciatic pain.




FIG. 9

Case 3. Preoperative roentgenogram, with patient standing.

apophyseal joints. This finding is the criterion of ankylopoietic spondylarthritis.

The view here presented differs from that commonly expressed in the literature. The roentgenological findings upon which it is based, however, are consonant with early anatomical investigations (Fraenkel, Leri, Simmonds, and Sivén) that have recently been confirmed in every detail.[18] It seems, therefore, that ankylopoietic spondylarthritis is a typical atrophic arthritis of the apophyseal joints.

Secondary changes may occur subsequent to this inflammation, although not of necessity always associated with it. These secondary changes consist in ossification of ligaments, especially of the ligamenta flava (Fig. 9) which histologically participate in the inflammatory proliferation of the synovial membranes.[14, 18] Calcification of spinal ligaments is a very common and totally uncharacteristic response to a great variety of vertebral lesions,—inflammatory, degenerative, destructive, or traumatic. The ossified longitudinal ligaments, when tangentially projected, [13] the increased radiolucence of the bodies, and the rodlike ankylosis combine to give the appearance of a "bamboo spine". The intervertebral spaces, with normal discs, represent the nodes of the bamboo. The calcified ligaments appear stretched rather than tortuous as in diseases associated with thinning of the discs. Slight widening of the intervertebral spaces [33] occurs occasionally, indicating that the discs, remaining normal, compress the rarefied vertebral bodies.



FIG. 7-B

Lumbar spine of patient shown in Figs. 6-A and 6-B. Only one apophyseal joint space is clearly distinguishable (arrow); the others are filled with bone substance. The longitudinal ligaments are ossified.

Admirably described by the discoverers, Marie and Leri, the combination of systemic bony ankylosis of the facets with ossification of the ligaments corresponds to the clinical entity, *spondylose rhizomélique*. Because of the very marked degree of ligamentous calcification characteristic of advanced phases, some authors [28, 41] regard this disease as a



FIG. 7-A

Lumbar spine of patient shown in Figs. 6-A and 6-B. Bamboo spine. Involvement of the sacro-iliac articulations.

than six months the outlines of the facets become irregular; after this time they are no longer recognizable. Again, within not less than about twelve months, bone substance of perfectly regular structure fills the original joint space; under exceptionally fortunate circumstances, one is able to observe this new bone forming at the facets and growing slowly from either facet into the narrowed joint space (Figs. 8-B and 10). When this bony ankylosis is complete, adjoining articular processes are no longer distinguishable, for the whole region involved shows bony fusion of the



FIG. 9

Oblique view corresponding to Fig. 8-B. There is ossification of the ligamenta flava (arrows). The lower two joint spaces are still visible, but narrow; their facets are ragged. The hazy shadow covering one intervertebral space (*x*) corresponds to the ossified longitudinal ligament shown in Fig. 8-B.



FIG. 10

Ankylopoietic spondylarthritis. The thoracic apophyseal joint spaces are narrowed and their facets are ragged (arrow). The patient was a male, fifty-seven years old, with persistent herpes zoster and rigidity of the thoracic spine.

observed, unless the condition is associated with some other changes of a different nature. In a localized type of spondylosis ossificans, only the ligamenta flava calcify,[2] but even then the apophyseal articulations are found intact (Fig. 12).

In ankylopoietic spondylarthritis, ossification of the ligamenta flava usually occurs during the period at which ankylosis becomes bony, as made evident by oblique dense lines at the posterior borders of the ankylosed joints. On the other hand, the longitudinal ligaments often calcify in a section of the spine distant from the seat of ankylosis.

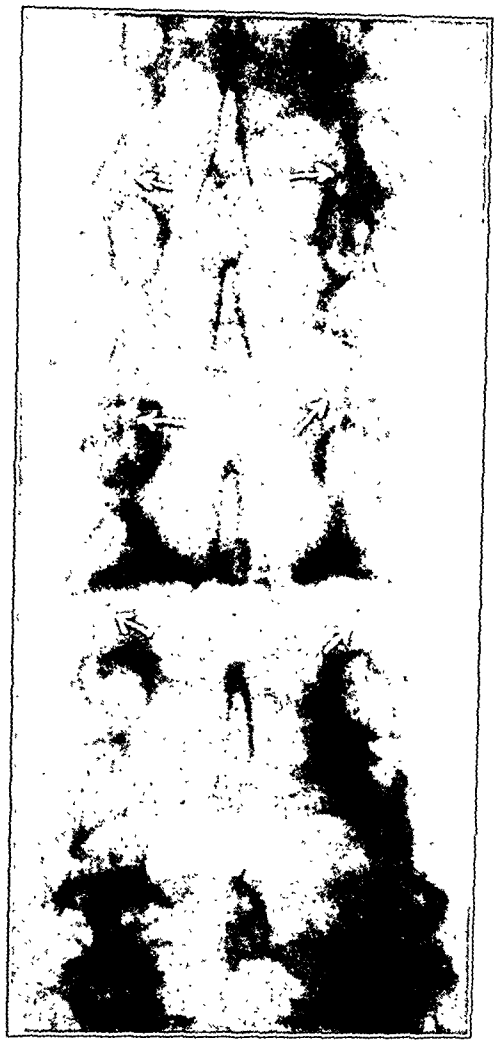


FIG. 8-A

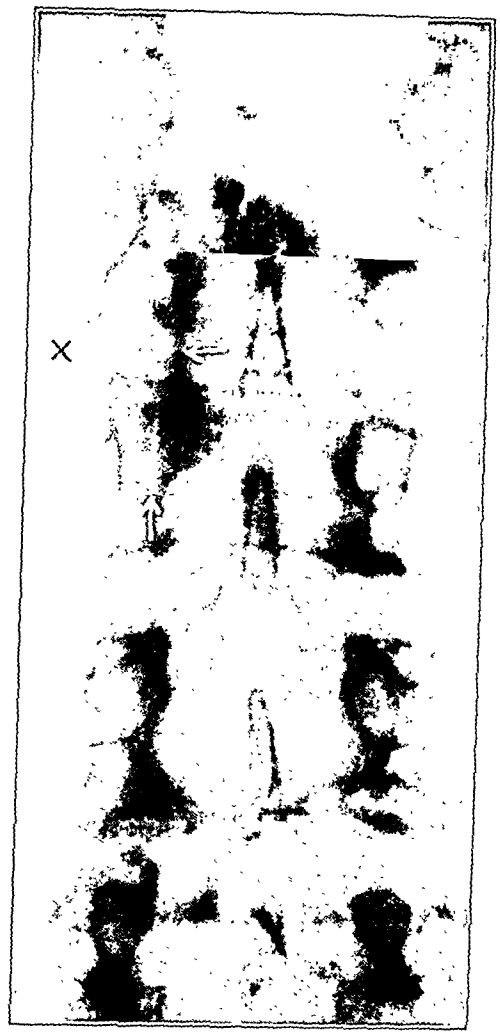


FIG. 8-B

Ankylopoietic spondylarthritis. *Roentgenograms of lumbar spine.*

*Fig. 8-A: The apophyseal joint spaces are still visible (arrows), but the articular processes are rarefied and the facets are ragged.*

*Fig. 8-B: Twenty-nine months later.* Ankylosis has taken place in all but one joint (arrows), and parts of the longitudinal ligaments have ossified (*x*). Note that the bone density of the vertebral bodies is less diminished than in Fig. 8-A, showing that rarefaction is more pronounced in the inflammatory stage than during the ankylosing phase.

The patient, a female, aged thirty-one years, has had pain and stiffness of five years' duration.

special "syndesmotic" type of chronic arthritis. Others [24, 36] have classified *spondylose rhizomélique* as a form of spondylosis ossificans ligamentosa. The latter condition, however, is determined anatomically by systemic ossification of the ligaments in the absence of changes of discs and apophyseal joints. Usually discovered accidentally in persons over fifty years of age during examinations of the chest, these changes are not associated with clinical symptoms. The posture is not altered (Fig. 11-A). Invariably, the apophyseal joints remain normal (Fig. 11-B). The thoracic spine is commonly the seat of the most extensive calcification, and the more mobile cervical and lumbar sections are less involved, wherefore mobility is usually intact. Radiating pain in the extremities is never



FIG. 11-C



FIG. 11-D

The intervertebral foramina may be reduced in width to less than one-half of their original diameter (Fig. 13) by concentric calcifications.[32] At earlier stages, the swollen capsule also may compress the nerve roots. Whether or not such constriction will lead to actual compression of the nerves depends on the relation between the width of the foramina and the caliber of the nerves, for, as previously mentioned,[32, 34] radiculitis is more common in diseases of the lower cervical and lower lumbar spine, where the thickest nerves pass through foramina not wider than those in the neighboring regions.

Relations to other "rheumatic" affections have been reported,—for example, iritis[44]; and it is well known that arthritis of the costotransversal joints[14], of the sacro-iliac articulations[16], of the hips and shoulders[27, 28], and of the hands or feet[43] is sometimes superadded. The sacro-iliac joints were found affected within one year after the onset of spinal rigidity in ten out of eleven patients; the costotransversal joints, in three cases more than five years after the condition of the spine had been discovered; and the hip joints, one knee,



FIG. 12

Spondylosis ossificans ligamentosa localisata (Bakke). Only the ligamenta flava are ossified (arrow). The apophyseal joints are free.



FIG. 11-A



FIG. 11-B

Difference between spondylosis ossificans ligamentosa (Figs. 11-A and 11-B) and *spondylose rhizomélique* (Figs. 11-C and 11-D). The patients have been photographed in their accustomed posture.

Figs. 11-A and 11-B: Spondylosis ossificans: normal posture; pronounced ossification of longitudinal ligaments (*x*) and normal apophyseal joints (arrows); normal vertebral bodies and intervertebral spaces.

Figs. 11-C and 11-D: *Spondylose rhizomélique:* characteristic posture; spine stiff and flexion of thigh on diseased hip; apophyseal joint spaces ossified (arrows) and vertebral bodies greatly demineralized; ossified ligament (*x*); typical ankylopoietic spondylarthritis.

This series shows how little the two diseases have in common.

However, only when ankylosis of the most affected part is complete do all the ligaments, including the ligamenta interspinalia, ossify as a whole. If this "*rideau osseux*"[1] (bony curtain) becomes very dense, the apophyseal articulations are overshadowed and no longer distinctly visible, but this is quite exceptional. It would seem evident, then, that spondylosis ossificans ligamentosa is not to be confused with spondylarthritis ankylopoietica.

In the latter condition, rigidity does not depend upon actual ankylosis of the facets, but is well marked as soon as cartilage is destroyed. This suggests that it is the inflammatory rather than the subsequent ankylosing process which leads to stiffness, as in atrophic arthritis.

Quite commonly the whole of the spine is not involved equally and simultaneously; therefore, various phases of the disease overlap in the selfsame person before ankylosis is complete. The process may remain confined to one part of the spine for many years (Figs. 7-A and 14) or even for the entire lifetime, in which case demineralization seems less pronounced (Fig. 14).

because of pain in the neck and the shoulder girdle; but in the remaining eight patients, the condition was discovered accidentally, and no clinical symptoms were associated with it. In thirteen of the cases, endamoeba histolytica was found in the stools.

Roentgenologically, the thoracic spine was found to be affected in seven cases, the lumbar spine in three, and the cervical spine in four. The articular processes were greatly increased in density; the facets were ragged; the apophyseal joint spaces were irregularly narrowed; and there were thorn-shaped exostoses at the posterior borders of contiguous facets (Figs. 15-B, 15-C, and 15-D). These changes were confined to one articulation in five cases, and to two or three joints in three cases; while, in the others, the whole cervical or thoracic spine was involved. The intervertebral spaces were normal, which shows that the discs were not affected; the vertebral bodies were intact; and there was no abnormality of posture. In three cases, parts of the anterior longitudinal ligaments were calcified.

*Hypertrophic Spondylarthritis in Abnormal Posture*

Eburnation and exostoses may develop wherever abnormal mechanical stress persists after having caused damage to the cartilages or bones upon which it acts.[4, 26, 39] In the spine, eburnation and exostoses develop in vertebral *bodies*,—for example, when abnormal contact between them or tension upon ligaments is produced by thinning of the intervertebral discs, [4, 32, 39] and in abnormal positions resulting from fractures, scoliosis [26], and the like.

Similarly, increased bone density and exostoses may develop in the *articular processes* when the articular cartilage has thinned down as a consequence of persistent pressure upon it,—for example, when by thinning of the intervertebral discs (traumatic or degenerative) the subjacent (superior) articular process is displaced forward,[32, 35, 50] or when deviation of the spinal axis in scoliosis or fractures causes compression (unilateral or circumscribed) of apophyseal cartilages.[26]



FIG. 14

Ankylopoietic spondylarthritis arrested and localized. There is bony ankylosis of one apophyseal joint (arrow) and the adjacent joint spaces are greatly narrowed. Thorn-shaped prominences at the margins of the vertebral bodies are present, indicating partial ossification of their longitudinal ligaments.

The patient, a teacher, aged fifty-seven years, gave a history of pain and stiffness about twenty-five years previously. The pain had subsided entirely after five years, but slight stiffness persisted. Only the lumbar region was involved.

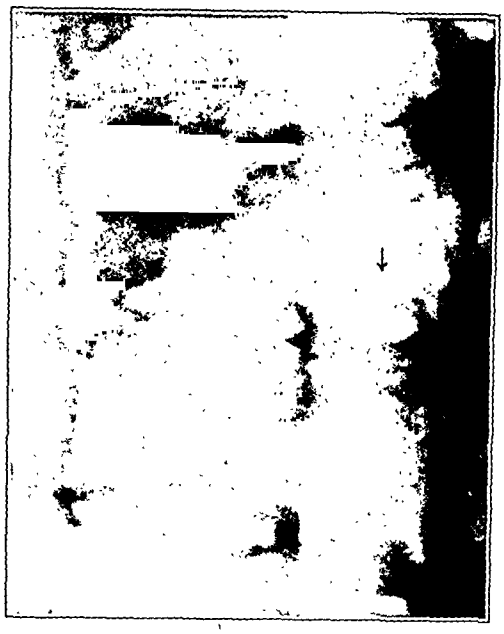


FIG. 13

Ankylopoietic spondylarthritis. Ossification of all the ligaments. Constriction of one intervertebral foramen by concentric ossification (arrow). The apophyseal joints are ankylosed and are not distinguishable.

and one foot, in one patient three years after ankylosis of the whole lumbar spine had taken place. On the other hand, in chronic atrophic arthritis involving, for example, the hands, the elbows, the knees, and the feet, the author has not been able to find similar changes in the column. The variable etiology of these diseases may play a part in determining the inconstancy of these interrelations.

It would appear justifiable perhaps to consider the three types of atrophic spondylarthritis—acute, chronic, and ankylopoietic—as phases of a single continuum without assigning to any single one or to all of them a specific cause. The pathological findings described may be the expression of reactions of these areas to stimuli of a number of kinds, but the reaction may stop at any point, or it may continue to the stage described as ankylopoietic spondylarthritis.

### *Hypertrophic Spondylarthritis*

Roentgenologically, hypertrophic arthritis is determined by increased bone formation within and around the articular surfaces. Hence the roentgenological determination differs of necessity from the anatomical. The primary lesion is localized in the cartilage, and this obviously causes the narrowing of the joint space seen in the roentgenogram,—either uniform, as in destruction of the entire cartilaginous layer; or irregular, as in partial destruction. Both may be masked by articular effusion, which is common in the disease.

Inflammatory osteoporosis (rarefaction) of the adjoining epiphyses, typical of atrophic arthritis, is not characteristic of the hypertrophic form. However, since hypertrophic arthritis is frequently the eventual outcome of some low-grade infectious (atrophic) arthritis,[13, 48] hypertrophic and atrophic changes may become superimposed.

In the apophyseal articulations, the disease occurs in one of two independent forms,—primary, and consecutive to postural alterations.

#### *Primary Hypertrophic Spondylarthritis*

Fourteen cases have been observed,—nine males and five females, all over fifty-three years of age. In three cases, the spine was examined because of herpes zoster that had persisted or recurred during four, seven, and eleven months respectively; in three others, examination was made




FIG. 10

Case 3. Three and a half years after operation, with patient standing.



FIG. 15-A



FIG. 15-B



FIG. 15-C

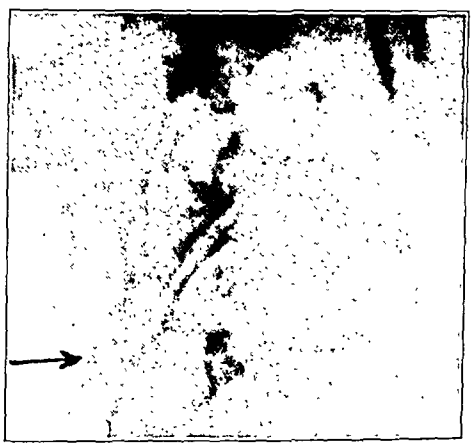


FIG. 15-D

Fig. 15-A: Normal lumber apophyseal joints.

Figs. 15-B, 15-C, and 15-D: Three cases of primary hypertrophic spondylarthritis: joint spaces narrowed; facets ragged; articular processes greatly increased in density and deformed by exostoses (arrows). Ankylosis by fusion of exostoses in one lumbar joint in Fig. 15-B indicated by *x*. Intervertebral spaces and vertebral bodies normal. Three cases of chronic amoebiasis.

Roentgenologically, increased density and exostoses appear mainly at the tips of the displaced facets. In the lower lumbar articulations, increased density of the articular processes is normal, because the overlapping of the cylindrical facets and the superimposition of the iliac bone

produce, in the oblique view, a summation of bone shadows (Fig. 15-A). By the ragged outlines of the facets and the narrowing of the joint space, the abnormal joint can be distinguished from the normal joint (Figs. 15-B and 15-C). Pathological bone formations of contiguous facets may fuse.[26, 39] This results in a type of bony ankylosis distinguishable from that found in ankylopoietic spondylarthritis by the absence of general rarefaction and the presence of residual exostoses. The facets, in all these conditions, are *not* parallel in position, their displacement being one of the primary causes of the whole process.

In the sixty-one cases observed, the clinical symptoms were those commonly found correlated with the condition underlying the displacement of the facets. Pain, localized or radiating, was the chief complaint. In most cases it was more pronounced during rest, especially in the small hours of the night when the patients, after a long period of sleep,



FIG. 16-A

"Discogenetic" hypertrophic spondylarthritis. The intervertebral spaces are narrowed (x), indicating thinning of the corresponding discs. The apophyseal joint spaces at this level are greatly narrowed, and their facets are ragged (arrows). Exostoses are present. There is superior displacement of the subjacent articular processes.



FIG. 16-B

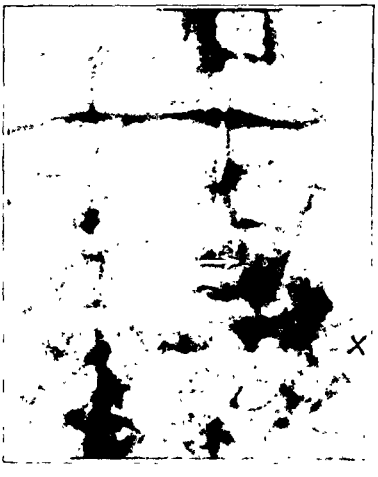


FIG. 16-C



FIG. 17

"Discogenetic" disease. The intervertebral space is narrowed (*x*). There are no changes at the vertebral bodies, but upward displacement of the subjacent articular process (arrow) has occurred, with narrowing of the apophyseal joint space and increased density of the articular processes.

would be awakened by "rheumatic" pain in the shoulders, the arms, the lower back, or the neck. A sensation of stiffness, most marked in the early morning, commonly interferes with washing and dressing; in the course of the day both pain and stiffness become less acute. Rigidity was most pronounced in three cases, in which one articular process, impinging upon the adjacent vertebra,[32, 34] was surrounded by a broad area of intensively increased bone density (Figs. 15-C and 16-C).

The inconstancy of the relations between hypertrophic spondylitis (a disease characterized by exostoses at the margins of the vertebral *bodies*) and hypertrophic spondylarthritis has been repeatedly discussed.[18, 26] In fact, changes in the apophyseal joints were evident in only 14 per cent. of our cases of hypertrophic spondylitis. This is not surprising, for the apophyseal joints differ in both structure and function from the intervertebral synchondroses that are formed by the discs and the adjacent vertebral surfaces. The vulnerability of the articular cartilage [4, 48] is variable in different persons; therefore, mechanical stress does not of necessity lead in every instance to lesions of cartilage inducing arthritis. Hypertrophic spondylitis is very often the result of lesions of the discs; this was shown as early as 1824.[49] On the other hand, thinning of the discs does not invariably lead to increased bone formation at the vertebral bodies (Figs. 16-A and 17). Similarly, the abnormal stress upon the facets in this condition does not of necessity induce lesions of cartilages. It would seem that both the vulnerability of the cartilage and the readiness of the bone to respond by formation of exostoses are important factors in the pathogenesis of these conditions.

This is shown by those instances in which no bone reactions develop at both the vertebral bodies and the articular processes, in spite of marked thinning of the discs, contact between the bodies, and pronounced thinning of the articular cartilages (Fig. 17). In these cases, none of the characteristics of hypertrophic arthritis become evident roentgenographically, for only the intervertebral and the joint spaces seem to be affected; the bones are not involved. On the other hand, in thinning of the discs, enormous exostoses at the corresponding vertebral bodies may be found

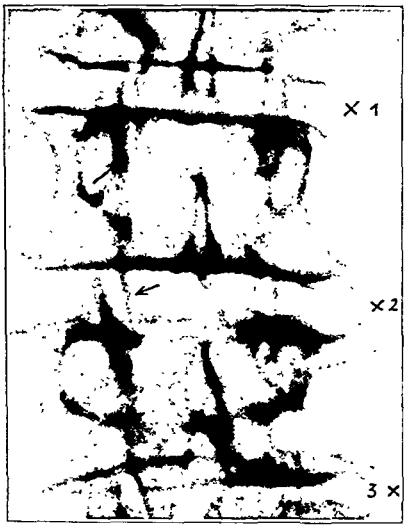



FIG. 18-A




FIG. 18-B

"Discogenetic" hypertrophic spondylitis of the upper lumbar spine. Anteroposterior and oblique views. There are large exostoses at the vertebral bodies adjacent to the narrowed intervertebral spaces (*x*), but no changes in the apophyseal joints (arrows).

in the absence of narrowing of the apophyseal joint spaces and of any changes in the facets. This indicates that the vertebral bodies did respond to the abnormal mechanical stress produced by the thinning of the discs (Figs. 18-A and 18-B), but the cartilages resisted.

Regardless of the presence or the absence of these secondary changes, thinning of the discs is the cause of their eventual development, for it leads to contact between vertebral bodies, to abnormal tension upon ligaments, to displacement of articular processes, and to narrowing of the intervertebral foramina. The totality of these alterations has previously been referred to as "discogenetic disease",[32, 35] and for this reason the type of spondylarthritis that may develop in the course of the lesion is here designated as the "discogenetic" form of hypertrophic spondylarthritis.

### *Secondary Infection*

Seventeen cases have been observed. In fourteen instances, tuberculosis of the vertebral bodies involved the articular processes; in three cases, an inflammation associated with condensation of the vertebral bodies (hypertrophic spondylitis) had spread to the articulations, as made evident by increased density of the articular processes. The joint spaces involved were found to be narrowed in all these cases. Persistent pain, impaired mobility, and rigidity of the segment involved were the main clinical symptoms. Tuberculosis, infection with brucella[26], osteoperiostitis[20], and osteomyelitis of vertebral bodies[26] have been reported to involve the articular processes. This is a rare occurrence,—in only fourteen out of eighty-one cases of Pott's disease was definite evidence of



FIG. 19-A

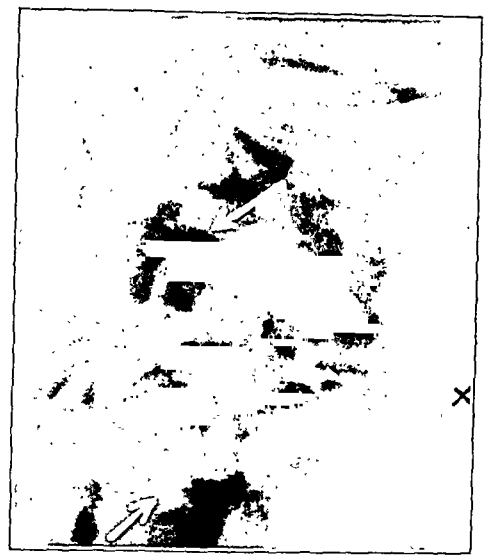


FIG. 19-B

Pott's disease. Collapse of lumbar vertebrae (*x*).
Fig. 19-A: The articular processes are not involved (arrow).
Fig. 19-B: There is slight rarefaction of the articular processes of the diseased vertebra, with indistinct outlines of the facets and blurring of the corresponding joint spaces (arrows).

articular involvement found. Even when the vertebral bodies have thinned down to a few millimeters in height, the articular processes may remain intact (Fig. 19-A). As long as the discs are not affected, they expand into the bones that have grown soft[39], thereby maintaining the normal distance between the articular processes and hence between the cartilages. Similarly, in systemic rarefaction inducing collapse of the vertebral bodies[33], or in vertebra plana (Calvé), the articular processes are rarely involved (Fig. 20). Consequently, the clinical symptoms are commonly mild as compared with the pronounced anatomical changes. One finds quite a number of patients with vertebrae destroyed by fractures, tumors, or infections, who have practically none of the clinical symptoms typical of spinal lesions.



FIG. 20

Platyspondylia aortosclerotica. There is flattening of the vertebral body (*x*), but no changes in the articular process (arrow) are visible.

### *Traumatic Lesions*

Fractures of articular processes are not very common; the author has seen four cases. Both the fracture line and the displacement are easily recognizable in roentgenograms taken in the oblique position, or in lateral views of the cervical spine (Fig. 21). The callus formations, if any, are very

small. Three patients, after a fall, had developed segmental neuritis, without being conscious of a spinal lesion; the fourth had severe pain in the spine and marked rigidity, but this was probably due to a coexisting hypertrophic spondylarthritis.

*Isolated Rarefaction of Individual Articular Segments and Articular Processes*

Demineralization, irregular bone structure, and decrease in height of one articular process or of the two processes that form one articular segment have been observed in eight cases in the absence of any demonstrable changes in the corresponding joint spaces, the vertebral bodies, and the discs (Fig. 22). In one case recently observed, the adjacent facet was found slightly deformed by exostoses surrounding the area opposite the tip of the diseased articular process; in other instances, the superjacent process seemed to impinge upon the softened bone.[31] In six of the eight cases, the lesion affected the sixth inferior cervical articular process which, as previously reported[31], is often normally smaller and thinner than the adjacent processes, and is particularly liable to compression by the superjacent and subjacent processes during backward movements of the neck.



FIG. 21

Fracture of cervical articular process (arrow), the result of an accident two years previously. There is no pain in the spine, but the patient complains of tingling in the left finger tips. There is atrophy of the left interossei.

The lesion is invariably associated with severe radiculitis. There is no rigidity. The etiology is unknown; neither trauma nor malignancy has been involved.

*Tumors and Osteitis Fibrosa*

Destruction or erosion of the articular processes may be caused by various tumors (Fig. 23). In a case of Hodgkin's disease the author has found infiltration of the thoracic articular processes, as confirmed by autopsy, to be associated with persistent herpes zoster. In one case of osteitis fibrosa the articular processes were involved, but the joint spaces were normal. There was no rigidity.

*Anomalies*

Congenital aplasia of articular processes is rare. Differences in size and shape are common. Lack of bony union with the epiphysis forming the tip of the process appears as a radiolucent horizontal gap sometimes mistaken for a fracture line. None of these conditions is associated with clinical symptoms.



FIG. 22

Isolated rarefaction of one cervical articular process. The joint spaces and vertebral bodies are normal. There is severe radiculitis with trophic lesions in the left hand.



FIG. 23

Neurofibroma. Note destruction of the articular processes. There is palsy of the right arm.

Gaps in the interarticular portion (Fig. 24), the center of the articular segment, are responsible for spondylolisthesis;[39] the clinical symptoms vary according to the degree of both anterior displacement and reactive changes.[26]

## CLINICAL AND ANATOMICAL INTERRELATIONS

When attempting to correlate the clinical with the underlying anatomical conditions, one is faced, at the outset, by the fact that anatomical lesions of the apophyseal articulations are not always associated with clinical symptoms. The significance of this statement, however, is limited by factors illustrated in the following case histories:

CASE 1. A. B., female, aged fifty-four years, a teacher, was first seen on November 11, 1935. Roentgenographic examination of the genito-urinary tract revealed narrowing of the fourth lumbar and lumbosacral spaces and eburnation and marginal exostoses of the fourth and fifth lumbar vertebral bodies, with marked eburnation of their articular processes. The patient could not recall at any time having suffered from backache, lumbago, sciatica, or the like. The spine was freely moveable; there was no tenderness on pressure.

At examination on May 15, 1936, the patient complained of severe lumbago with bilateral sciatic radiation, and on April 12, 1937, she stated that she had been troubled by backache ever since the previous visit. Backward stretching, as when lifting an object from the floor, elicited pain in the back radiating down to the popliteal regions. The lumbosacral region was tender on pressure. The roentgenographic appearance of the

lumbosacral spine was identical with that found seventeen months previously.

CASE 2. A. S., male, fifty-three years of age, a merchant, was seen on June 6, 1937, complaining of dull pain in the right shoulder and weakness of the right arm. The right deltoid muscle was much thinner than the left. The grip of the right hand was weak (the patient was right-handed). There was an area of diminished sensitivity to touch on the lateral part of the right forearm.

Roentgenographic examination revealed narrowing of the fifth and sixth cervical intervertebral spaces and subluxation forward of the sixth and seventh superior articular processes; exostoses on these processes bulged into the right fifth and sixth intervertebral foramina. The cervical spine was freely movable, and there was no tenderness on pressure or percussion.

The patient stated that he had never suffered before from any kind of rheumatism; his wife, however, affirmed that "for at least twenty years past" the patient had very frequently complained of rheumatic pain in the shoulders, stiffness of the neck, and, more recently, of tingling sensations in the finger tips. This reminded the patient that he had consulted several physicians during the past ten years because of rheumatic pains, the nature of which, however, he was still unable to recall. (The patient is intelligent, calm, and highly spoken of as a very reliable person.)



FIG. 24

Gaps in interarticular portion are visible. No displacement is present in the upper joint, but there is slight forward displacement (incipient spondylolisthesis) of the superior articular process of the lower vertebra, causing widening of the gap.

The patient was a female, twenty-four years of age, who complained of pain in the lower back.

CASE 3. A. J., female, forty-two years old, complained of pain in the right hand of eight years' duration and recently associated with weakness of the grip. Twenty years previously the neck had often been painful and "stiff". For the past three weeks pain in the left shoulder radiating to the finger tips had considerably impaired the use of the left arm and hand. There was no tenderness or rigidity of any section of the column. During the past five years, every imaginable mode of treatment had been attempted without relief. The spine had never been examined.

Roentgenographic examination on June 16, 1937, showed that the fourth and fifth cervical apophyseal joints were almost ankylosed. The discs were normal, but the ligaments were calcified.

These few examples out of many may serve to demonstrate the following points:

1. In the presence of definite anatomical changes, clinical symptoms may be temporarily absent, for the symptoms may develop a long time after anatomical changes have been accidentally discovered (Case 1).

2. The history is not reliable, "rheumatic" pains being subconsciously minimized (Case 2).

3. Clinical symptoms may fail to suggest a spinal lesion; consequently roentgenographic examination is often omitted (Case 3). Many cases thus escape statistical evaluation.

4. In spite of marked and persistent discomfort in the extremities,

there may be no symptoms and signs referred to the spine (Cases 2 and 3).

5. Generally speaking, the roentgenographic appearance of apophyseal lesions *in vivo* is clinically more significant than their aspect on autopsy. In anatomical investigations, the occurrence of narrowing of intervertebral foramina sufficiently marked to account for compression of nerves has been denied.[45] This is easily explained by the fact that, on autopsy, dehydration of nerves and decongestion of inflamed tissues, as well as the absence of postural influences that lead by displacement of bones to narrowing of foramina *in vivo*, make the interrelations appear different from those roentgenographically recognizable in the living patient examined in the upright position.

In this connection, however, it must be strongly emphasized that there neither is nor could possibly be a direct correlation between the degree and amount of the anatomical changes observed roentgenographically and the severity of the clinical symptoms. It is in the incipient stages that pronounced pain and disability are common, while the roentgenographic signs are not very marked. On the other hand, extensive bone changes are, in general, merely the result of a chronic process; and immobilization by exostoses and ankylosis may prevent further irritation of the joints.

## DISCUSSION

For the recognition and comprehension of the diseases of the apophyseal articulations, it is necessary to consider them primarily and essentially as affections of true joints rather than as diseases of appendices of the vertebral bodies. That these joints are also parts of the spinal column is of secondary importance in this respect, for it has been the author's experience that the interrelations between the different types of spondylarthritis and the various forms of spondylitis and spondylosis are much less definite and constant than has been believed.

Roentgenologically, the two main types of arthritis reappear in affections of the apophyseal joints: atrophic spondylarthritis, marked by swelling of the capsule, rarefaction of bones, and, later, by destruction of cartilages; and hypertrophic spondylarthritis, in which hypertrophic bone changes are consequent upon lesions of the cartilage. As in all other localizations of arthritis, a combination of atrophic with hypertrophic changes may occur,—*e. g.*, in low-grade infections. Another form develops when, for reasons not yet known, the articular bone does not respond to the injury resulting from loss of cartilage. Secondary involvement of the joints in diseases of the adjacent bones may occur just as in other articulations, but it is very noteworthy that affections of the vertebral bodies, both localized and systemic, involve the articulations only rarely. The compact bones of the pedicles seem less liable to infection and rarefaction than the spongy vertebral bodies, and the compensatory expansion of the intervertebral discs (if they are not affected by the disease), as well as the

considerable resistance of the articular cartilages to mechanical stress, protects the articulations from injury. The following observations suggest that hypertrophic spondylarthritis develops chiefly in those patients in whom the cartilages are especially vulnerable:

1. There is a type of hypertrophic spondylarthritis in which the cartilaginous lesion cannot be accounted for by abnormal mechanical stress; in thirteen of the fourteen patients in this group, endamoeba histolytica was found in the stools, and relief was obtained by antiamoebic treatment. In the Near East, from 12 to 28 per cent. of the population are infected with amoebae, but the vast majority of these patients have no signs of hypertrophic arthritis.

2. Primary thinning of the intervertebral disc causes, by displacement of the superior articular process, very marked mechanical stress upon the facets. However, in only six out of 233 patients with thinning of the cervical discs and in forty-nine out of 204 patients with thinning of the lumbar discs were roentgenographic signs of hypertrophic arthritis found at this level.

Clinically, the infectious origin of atrophic spondylarthritis and of the type of hypertrophic spondylarthritis mentioned is suggested by the coexistence with various infections, and by the cure or arrest obtained by treatment of the underlying disease. As in other localizations, atrophic and hypertrophic arthritis in the apophyseal joints differ, as a rule, in the clinical course: atrophic spondylarthritis is marked by a more continuous chronicity, while hypertrophic spondylarthritis is usually associated with acute exacerbations alternating with periods at which the symptoms are very mild. Consequently, in hypertrophic spondylarthritis, one may find well-marked anatomical changes in patients who are free from discomfort during this examination, but, if one has an opportunity to reexamine these patients at intervals, symptoms of spondylarthritis will be observed almost invariably at some time or other. As in other joints, the inflammatory phase is marked by pain (spontaneous and on pressure) and by impaired mobility. Stiffness may be due to muscle tension, but rigidity independent of muscle spasms has been found to be invariably associated with narrowing of the apophyseal joint spaces indicative of thinning of the articular cartilage. This rigidity, unlike that caused by muscle tension, persists after the pain has subsided. Rigidity is not always caused by calcification of ligaments, or by the diminution of the distance between vertebral bodies that results from thinning of the discs, or by fusion of marginal vertebral exostoses. Even operative grafting of several vertebrae may have little influence upon the mobility of the spine.[8] On the other hand, thinning of the articular cartilages of one single apophyseal articulation may and does produce rodlike rigidity of a whole spinal section.

The observations leave little doubt that the integrity of the *articular cartilages* is essential to the normal mobility of the spine. This is substantiated by the fact that impaired mobility of the spine is found only in a

certain number of patients with radiating pain in the limbs that has been shown to be produced mainly by primary thinning of the discs (Badgley; Hodges and Peck; Oppenheimer; and Williams). In these patients, there may be no pain in the spine itself, in spite of radiculitis causing severe trophic disturbances.[46] In only sixty-one of the 437 patients with "discogenetic disease" did the author find pain (spontaneous or on pressure) and a certain amount of rigidity of the affected section. In forty-nine of these there was definite narrowing of the apophyseal joint spaces at the level of the collapsed intervertebral space, with or without hypertrophic changes of the articular processes.

On the other hand, radiculitis is by no means typical of discogenetic lesions; various diseases may, at least at certain stages, affect the intervertebral foramina.[32, 34] This occurs, for example, by constriction of their lumen during proliferative inflammation in acute spondylarthritis, or in isolated rarefaction of articular processes. However, the present observations reaffirm that pain in the spine itself usually precedes or accompanies radicular symptoms when the disease originates in the apophyseal joints.[34]

The classification of atrophic spondylarthritis is here given with some hesitation, but, because of the involvement of the synovial membranes and because of some demineralization in three of the cases, acute spondylarthritis is grouped with the atrophic type. This classification is now generally accepted, but it may well be that in the future an etiological classification will be possible, in which some types of both atrophic and hypertrophic arthritis are considered to be of infectious origin. Such a division into infectious and non-infectious arthritis has already proved its clinical value.[48]

## SUMMARY

In answer to the four questions posed at the beginning of this paper, it seems justifiable to conclude as follows:

1. The two main types of arthritis affect also the apophyseal joints. *Atrophic* spondylarthritis, associated chiefly with focal or general infection, occurs in an acute reparable form in which the cartilages are not involved; in a localized chronic type, marked by destruction of cartilage; and as a chronic, more or less systemic disease, ankylopoietic spondylarthritis. *Hypertrophic* spondylarthritis, marked by destruction of cartilage, but not necessarily by bone hypertrophy, is often the result of persistent changes in the position of the vertebrae; in another type, independent of mechanical factors, it is possibly of infectious origin (amoebiasis). *Secondary involvement* of the articular processes in inflammatory and rarefying diseases of the vertebral bodies is rare. *Isolated rarefaction* of the articular segments without cartilaginous lesions, another rare condition, is etiologically obscure.

2. Local pain (spontaneous and on pressure) and stiffness caused by muscle tension are found in active phases of any type of spondylarthritis.

Rigidity not caused by muscle spasms develops whenever articular cartilages are affected. Rigidity without pain is observed in quiescent hypertrophic and in arrested ankylopoietic spondylarthritis. In diseases of the vertebral bodies and intervertebral discs, local pain and persistent rigidity occur chiefly when the apophyseal articulations are involved. Radiculitis, which may develop in any disease that affects the intervertebral foramina, is not characteristic of particular lesions.

3. Atrophic spondylarthritis is independent of other systemic spinal diseases; there is especially no correlation either with spondylosis ossificans ligamentosa or with the various types of spondylitis. Hypertrophic spondylarthritis, being intimately related to postural alterations (mainly those resulting from "discogenetic" lesions), is often associated with traumatic changes,—hypertrophic spondylitis, scoliosis, and the like.

4. Acute atrophic spondylarthritis can be cured; chronic atrophic spondylarthritis can be arrested by successful treatment of the coexistent infection. In hypertrophic spondylarthritis, the treatment depends upon the underlying lesion (mechanical or infectious).

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correction was obtained and has been maintained at the sites of the pseudarthroses in the previous area. The patient is normally active and has no symptoms referable to the spine. The shoulders are level, and the head and trunk are well centered over the pelvis. There is good flexibility in the unfused portions of the spine.

*Case 3 (Figures 9 and 10)*

S. B., female, aged thirteen years, had an "idiopathic" left thoracolumbar scoliosis, the primary curvature extending from the tenth thoracic to the fourth lumbar vertebra, with the apex at the first lumbar vertebra. Only the precorrective roentgenogram (Fig. 9) and the latest postoperative standing view (Fig. 10) are presented to show the undesirability of overcorrection of a curvature and fusion in this overcorrected position. Figure 10 was taken three and a half years after spine fusion from the tenth thoracic to the fourth lumbar vertebra. Note that the original left curve has been converted into a right curve, and that the end vertebrae, particularly the fourth lumbar, are considerably overcorrected,—that is, they now tilt in a direction opposite to that in the original curve. To fuse a curve which has been overcorrected, or even a curve whose end vertebrae have been overcorrected, demands that the compensatory curves above and below the fused area not only straighten of their own muscle power, but actually reverse themselves to maintain good alignment. Overcorrection of a curve or of its ends means for any individual case more correction than the compensatory curves can take care of, and will result in a lateral shift of the body opposite to that present originally. In this particular patient the thoracic compensatory curve (the fourth thoracic to the tenth thoracic) has straightened nearly completely after three and a half years and may eventually reverse itself, but one should not plan for such an eventuality in selecting the fusion area. A curvature should not be fused in an overcorrected position.

*Case 4 (Figures 11, 12, and 13)*

M. K., female, aged fifteen years, had an "idiopathic" left thoracolumbar scoliosis extending from the eighth thoracic to the fourth lumbar vertebra, with the apex at the first lumbar (Fig. 11). There was a considerable shift of the trunk to the left with moderate prominence of the right hip. The curvature was corrected in the wedging jacket to the position shown in the spine-marker roentgenogram (Fig. 12). From the study of this roentgenogram, it was decided to make the rare exception of not fusing every vertebra in the primary curve, the so-called minimum area, but to leave out the eighth thoracic vertebra from the fusion. This was done because this end vertebra was overcorrected,—that is, its upper surface was tilted beyond a line transverse to the axis of the trunk (dotted line, Fig. 12). Therefore, in 1934, fusion was done from the ninth thoracic to the fourth lumbar vertebra.

Figure 13 shows the end result three years later. The alignment is

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be successfully utilized as an extensor there would seem to be little doubt regarding the value of this procedure.

"In those cases in which both groups of hamstring muscles are acting, the transference of the biceps with the tensors as described would probably give the best obtainable results from tenolysis for paralysis of the quadriceps."

Since 1926, sixteen cases of quadriceps paralysis, in all of which knee-flexion and hip-flexion contractures were present, have been treated by operative transference of the iliotibial band. In eight of these cases the biceps muscle was also transplanted in conjunction with the iliotibial band. In earlier cases the iliotibial band was merely freed and sutured to the patella, and the biceps was transferred according to the methods previously described by Crego and Fischer.

It seemed to the author that more radical dissection was necessary to utilize effectively the abundant muscle power available in that part of the gluteus maximus which is inserted into the fascia lata. It also seemed that the biceps muscle had not been sufficiently mobilized to place it in the position of strongest mechanical advantage for its new function. For these reasons the operative technique was gradually modified extensively. Those of us who have observed these cases under the original technique and later with the modified method feel thoroughly convinced that the more radical procedure is amply justified by the improvement in function.

## OPERATIVE TECHNIQUE

A long incision is made, beginning just below the greater trochanter and extending from the lateral aspect toward the middle of the dorsal surface of the thigh to the patella, and across the patella down through the tuberosity of the tibia. The edges of the skin are then reflected on each side by blunt dissection, fully exposing the fascia lata from the middle of the thigh to the inferior edge of the lateral surface. It is important that the reflection of the skin should be sufficiently wide to expose the insertion of the gluteus maximus into the fascia lata. The biceps tendon is next isolated just above the head of the fibula and, after two-thirds of this tendon has been stripped free from the head of the fibula, it is dissected upward until the muscle fibers of the short head begin to show. The dissection of the long head of the biceps only is then continued upward, either bluntly with gauze or by actually cutting it free from the short head. The long head of the biceps should be freed from surrounding structures sufficiently high to enable its course to be changed, so that it will enter the tunnel which is later made for the two tendons at an advantageous angle. There is a distinct line of separation between the short head and the long head, and it is possible to separate them easily. There is no advantage in trying to utilize the short head of the biceps, as it cannot be mobilized adequately without too much trauma, bleeding, and destruction of its own nerve supply; moreover,

# AN OPERATION TO IMPROVE FUNCTION IN QUADRICEPS PARALYSIS *

BY CARL C. YOUNT, M.D., PITTSBURGH, PENNSYLVANIA

In 1926 the author read before the American Orthopaedic Association a paper on "The Rôle of Tensor Fasciae Femoris in Certain Deformities of the Lower Extremities". In this paper emphasis was placed on the following facts:

1. The so-called "hip-flexion contracture", seen so frequently in untreated cases of anterior poliomyelitis, in most instances is not a true flexion contracture, but an abduction contracture, the structures chiefly involved being the tensor fasciae femoris, the portion of the gluteus maximus which is inserted into the fascia lata, and the pseudotendinous prolongation of these two structures,—that is, the iliotibial band.

2. Because of the insertion of the iliotibial band into the tuberosity of the tibia, contraction results in external rotation of the tibia on the femur and is a factor in causing knee flexion, especially in those cases in which the quadriceps is weak or paralyzed.

3. The biceps is an important contributory factor in the pseudo knock-knee, knee flexion, and rotation of the tibia in the presence of a paralyzed quadriceps.

Cases were also reported in which the three deformities—hip flexion, knee flexion, and paralytic knock-knee—were successfully corrected by division of the iliotibial band and by the lengthening of the biceps tendon. One case was described in which the iliotibial band was transplanted to the patella to replace a paralyzed quadriceps. The following comments were made in regard to this case.

"In those cases in which the quadriceps is paralyzed and the tensors of the fascia lata are active the advisability of utilizing the latter as extensors of the knee suggests itself. Spitzy has devised and practised rather extensively an operation utilizing the tensor fasciae femoris muscle for this purpose. In his operation no consideration is given to the fact that a fair portion of the gluteus maximus functions as a tensor of the fascia lata and acts conjointly with the tensor fasciae femoris muscle by means of its fusion with the latter in the ilio-tibial band. With this in view the operation has been modified to the extent that instead of stripping free a narrow portion of the fascia lata, up to the muscular insertion of the tensor fasciae muscle, a broad fan-shaped section of the fascia lata is included, the broad part being taken from the lateral and posterior surface, the dissection extending up to the lower edge of that portion of the gluteus maximus which is inserted into the fascia lata. . . . If that portion of the gluteus maximus which acts as a tensor can thus

* Read at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 10, 1933.

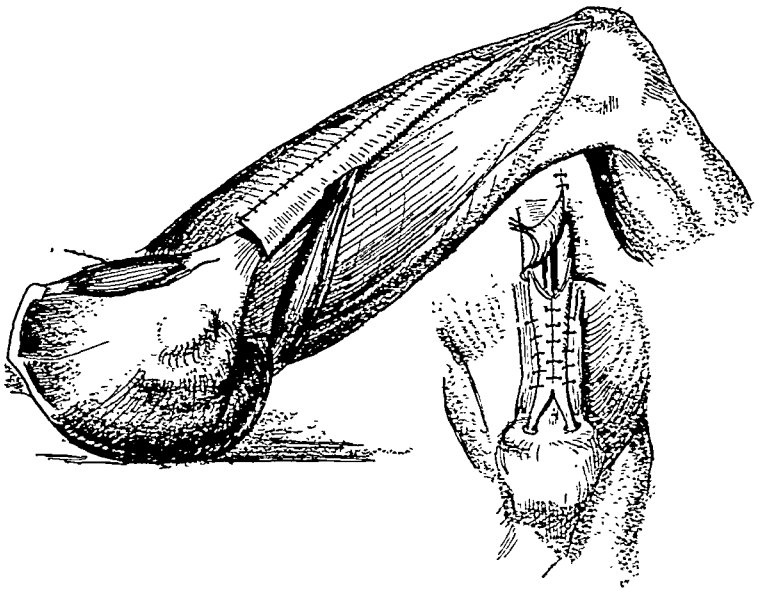


FIG. 3

upper third of the thigh. Where it approaches the insertion of the gluteus maximus it is widened out considerably and stripped free up to the point where the fibers of the gluteus maximus insert into it. The mesial edge of the section of the fascia is stripped up, so that it includes the tensor fasciae femoris.

Having freed the structures which are chiefly responsible for the contracture, it is found quite easy to correct the flexion and the rotation deformity at the hip and knee by manual force. It is advisable, however, to use a moderate amount of force and not to attempt to overcome fully the contractures at this time. In the most extreme cases in the author's series, not more than 20 degrees of hip flexion and 15 degrees of knee flexion have been present after the forced manipulation described. The final correction of these deformities should be deferred until after complete healing has taken place.

In the earlier cases it was found that the transposed structures remained too far out on the lateral surface of the thigh to give the maximum function. In order to transpose them to a position which would more nearly approximate that of the quadriceps, a tube, constructed from the inner lip of the cut fascia lata, is made by folding it upon itself toward the mesial aspect of the limb (Fig. 1). In the upper part of the thigh the tube should be so placed that it will lie laterally and then gradually extend obliquely toward the middle as it approaches a point about three inches above the patella. The transplant of tensor fasciae latae enters the tube at its top, but it is necessary to make a separate opening in the tube approximately two inches below the top for the biceps (Fig. 2). After emergence from the tunnel, the biceps is stitched to the fascial

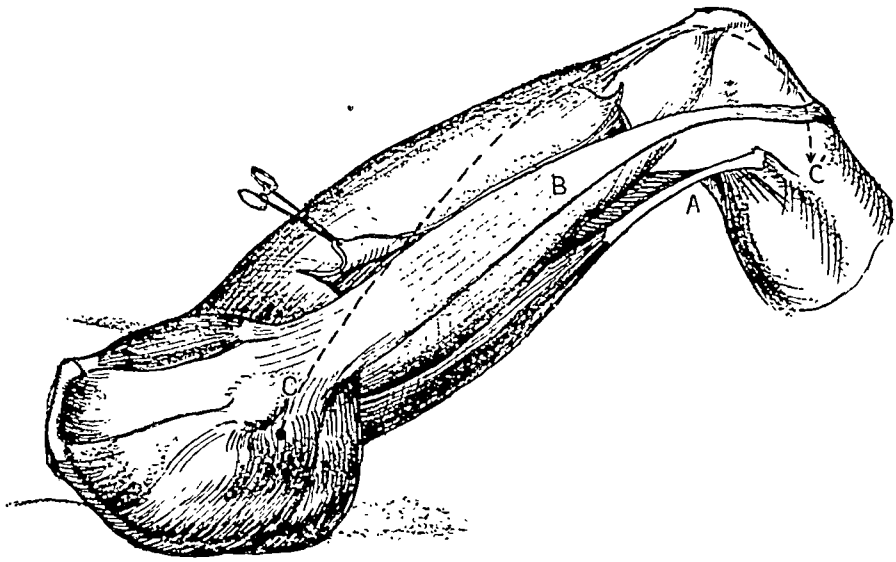



FIG. 1

Method of constructing tube: *A*, biceps; *B*, fascia lata and iliotibial band; *CC'*, line of skin incision.

if it is retained as a flexor of the knee, it is unquestionably valuable in preventing the development of genu recurvatum, which of course is a possibility in these cases, especially if the other hamstring muscles are weak. The insertion of the iliotibial band is next freed subperiosteally from the tuberosity of the tibia. A strip about half an inch in width is dissected free, extending from the tuberosity laterally across the surface of the knee joint up to the part of the iliotibial band which is well defined. Beginning about two inches above the knee joint, the strip of the fascia lata which includes the iliotibial band is widened gradually toward the

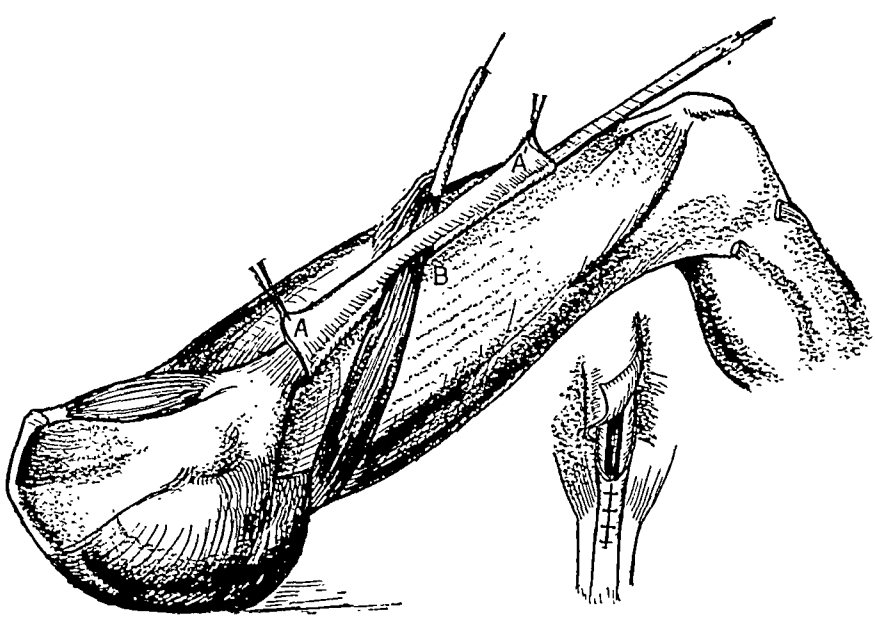



FIG. 2

The fascial transplant traverses the tube made by folding the fascia lata *A* to *A'*. The biceps enters the tunnel at *B*.

## COMMENT

This operation, of course, has been developed as a type of procedure to be used in a particular group of cases in which a fairly uniform type of deformity and similar residual power in the extremity are present. For that reason no attempt will be made to contrast it with other types of operations in which other muscles are utilized. It is the author's belief that there is no best operative procedure for the replacement of the paralyzed quadriceps, but each case presents its own problem and the type of operation to be chosen will depend upon the available muscle power for transference.

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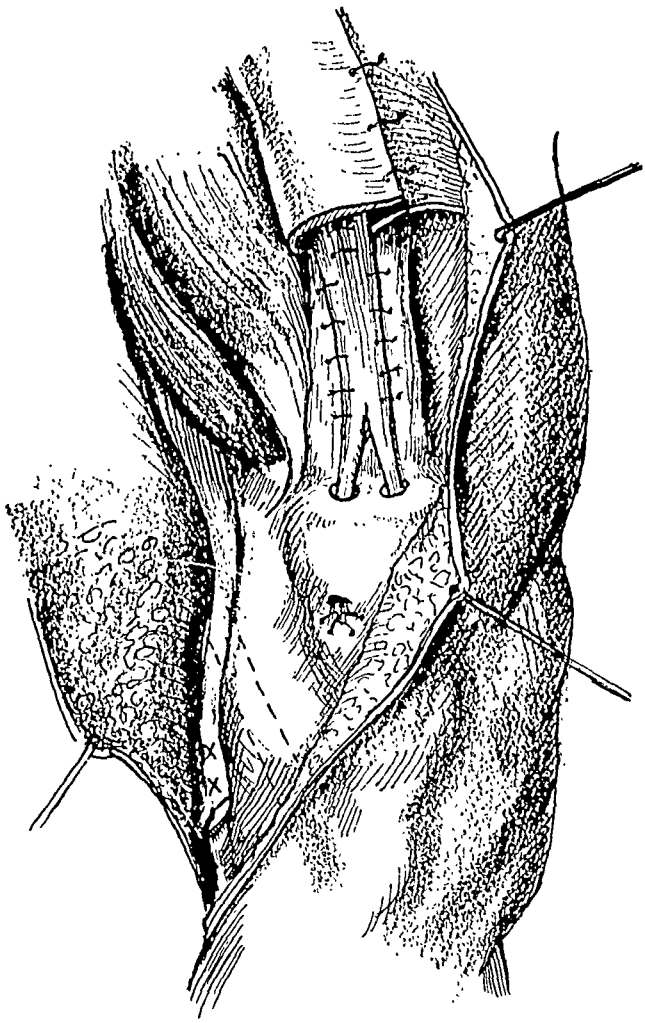


FIG. 4
Showing the plastic suturing completed.

transplant, as it will be found in most cases that the biceps will not reach the patella. Both these structures are then sutured to the quadriceps tendon, after the latter has been incised in the mid-line one and one-half inches above the patella. The fascial transplant is divided into two parts at the end, and is imbedded in two holes (punched or drilled) in the patella. (See Figures 3 and 4.)

After the usual closure of the wound, a cast, extending from the perineum to the toes, is applied. Moderate force only should be used in correcting knee flexion. In applying the cast the correction of knee rotation should not be overlooked. A strict Soutter position is not used immediately after the operation, but gradual correction of the hip flexion is accomplished by elevating the buttock by means of boards and pillows under the mattress.

## POSTOPERATIVE CARE

In cases with marked hip-flexion contracture, correction is deferred until approximately four weeks after operation, when the patient is placed in the strict Soutter position. Additional correction of the knee flexion is accomplished after the four weeks' period by means of a wedged cast.

At the end of the fifth week after the operation, massage and muscle reeducation are begun. In most cases old braces which these patients have been wearing are refitted and worn usually only for six or eight weeks. Most of the author's patients have been able to walk without braces so soon after the operation that he has not felt it justifiable to order braces. The only advantage of the brace is that if it is worn the patient can be discharged from the hospital more quickly.




FIG. 11

Case 4. Preoperative roentgenogram, with patient standing.

# "SPONDYLODESIS"

## The Use of the Short Bone Graft in Fusion of the Tuberculous Spine

BY J. DE MOL VAN OTTERLOO, M.D., 'S-GRAVENHAGE, NETHERLANDS

*From the Queen Sophia Memorial Children's Hospital*

Tuberculosis of the spine is a condition which may give rise to difficulties in treatment, not only from the general pathological, but also from the orthopaedic point of view. It is the author's purpose to discuss the causes of these difficulties and to advocate a method of treatment which has been found to improve the end results in many cases.

The spinal tuberculosis of children should be considered separately from that of adults, because, as a rule, the course is different.

In children spondylitis often leads to bony union of the involved vertebrae, while in adults the bony remnants of the vertebrae do not grow into one bone block and a pseudarthrosis remains as a result of the healing. Also, in the process of healing, the thoracic vertebrae behave differently from the lumbar vertebrae, due to the difference in anatomical structure. (See Figure 1.) When destruction of the body occurs in the thoracic spine, the upper thoracic vertebra tips forward, being caught on the superior articular processes of the thoracic vertebra below; whereas, in the lumbar spine, the upper lumbar vertebra may sink down more perpendicularly upon the lower vertebra, because the surfaces of the lumbar intervertebral articulations are able to slide vertically along each other, as they are placed in the sagittal plane. Consequently, in the lumbar column, there is a firmer contact between the fragments of the involved vertebrae, as the centra are vertical.

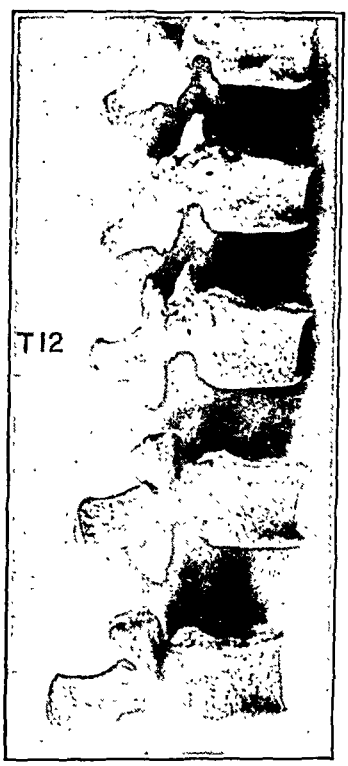



FIG. 1

Showing the tenth, eleventh, and twelfth thoracic vertebrae and the first and second lumbar vertebrae. In the twelfth thoracic vertebra the upper articulations are in the frontal plane, while the lower articulations have turned about 90 degrees and are placed in the sagittal plane.

In children a spondylitis of two or three lumbar vertebrae usually leads to bony union with or without minimal kyphosis; whereas in cases of involvement of the thoracic vertebrae frequently bony union does not occur and a kyphosis is unavoidable. In adults, however, neither thoracic nor lumbar spondylitis results in bony union, and a pseudarthrosis persists.

It should not be forgotten that, in the

course of the disease, bony union of the small intervertebral joints may occur, although one often finds, in studying specimens of a tuberculous spondylitis, non-union of both vertebral bodies and intervertebral joints.

As a matter of fact, in many cases in children, even after a long conservative treatment, there results a non-union,—a pseudarthrosis of the involved part of the vertebral column. The motion and flexibility of this pseudarthrosis may be considerable. Roentgenographic examination in such cases may give an idea of this condition.

To determine this pseudarthrosis, the examination is carried out as follows: The exposure is made with the patient in the lateral position and the spine in hyperflexion; then a second lateral exposure is made with the spine in hyperextension. When these roentgenograms are compared, the angle of inflexion—at the kyphos—will show in many cases a change of 20 degrees or more. This motion is in a most vulnerable place—a weakened area of the spine—which is continuously exposed to distortion, bleeding, and oedema, and eventually may be complicated by neurological symptoms. No doubt, many cases of recurrence of the tuberculous disease, as well as of back symptoms, are due to a more or less loose pseudarthrosis. To date, roentgenographic examination of all patients seen by the author because of recurrence of symptoms showed a lack of bone-block formation.

This condition may be compared with any pseudarthrosis resulting from tuberculosis,—for example, that of the hip. As the extrafocal fusion of a pseudarthrosis of the hip is considered to be the best treatment, it seems advisable to base the treatment of a like condition in the spine on the same principle,—namely, an extrafocal fusion of the involved vertebrae.

Jacques Calvé, of Berck, France, was the first to advocate the use of a short bone graft which fuses only the affected vertebrae, and the author believes that this is the correct procedure. If, after consistent conservative treatment, the bony fragments of the involved centra do not grow into one bone block, and a pseudarthrosis persists, a fusion of these vertebrae

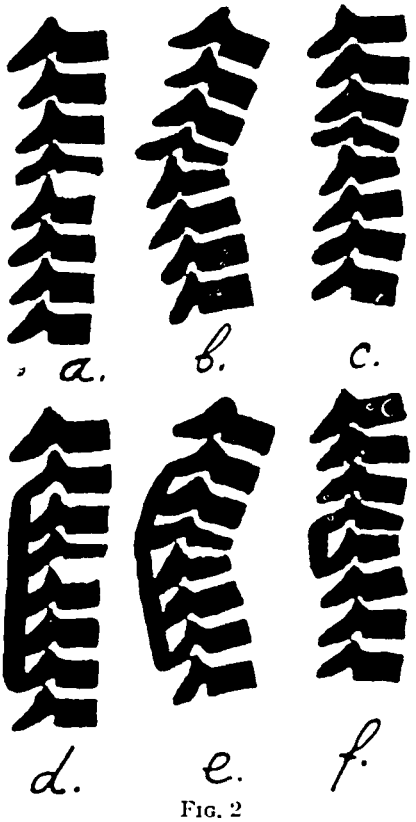



FIG. 2

Showing the natural physiopathological course of a case of tuberculosis of the spine (*a*, *b*, and *c*) with the formation of a compensatory lordosis (*c*). The long bone graft impedes both the collapse (*d*) and the formation of a lordosis (*e*). The spondylodesis (*f*) fuses only the involved vertebrae. (*Courtesy of Nederlandsch Tijdschrift voor Geneeskunde.*)

should be done. The author proposes calling this operation "spondylodesis", because of the analogy to arthrodesis for the fusion of a joint.

In the writer's opinion, the long bone graft, extending from two vertebrae above to two vertebrae below the focus, is based on a false principle. Since the long bone graft fixes together a number of vertebrae, it interferes with the natural correction of the parafocal spine,—the forming of a compensatory lordosis (Fig. 2,*c*). Furthermore, this fusion, which is usually done in the early stage of the disease, is objectionable for the following reasons: It cannot arrest the extension of the tuberculous disease, and it interferes with the process of repair, since it impedes the natural physiopathological collapse and the elimination of space between the destroyed vertebrae. Also, is not the contraction of the fibrous tissue, which results from tuberculous granulation, a *conditio sine qua non* for a thorough repair of any tuberculous focus?



FIG. 3

The use of the long bone graft is supposed to be advantageous, because it protects against the intrafocal pressure caused by the weight of the upper vertebral column, but pressure should not be feared during the stage of repair in which the spondylodesis is preferably done. It is even desirable as a functional stimulus to bone formation!

With the long bone graft, it is more possible to avoid motion between the involved vertebrae



FIG. 4



FIG. 5

Fig. 3 and Fig. 4: Patient with tuberculosis of the second, third, and fourth lumbar vertebrae, in whom total fusion of the lumbar spine by a long bone graft had been performed.

Fig. 5: Same patient as shown in Figs. 3 and 4, after removal of the superfluous portion of the graft.

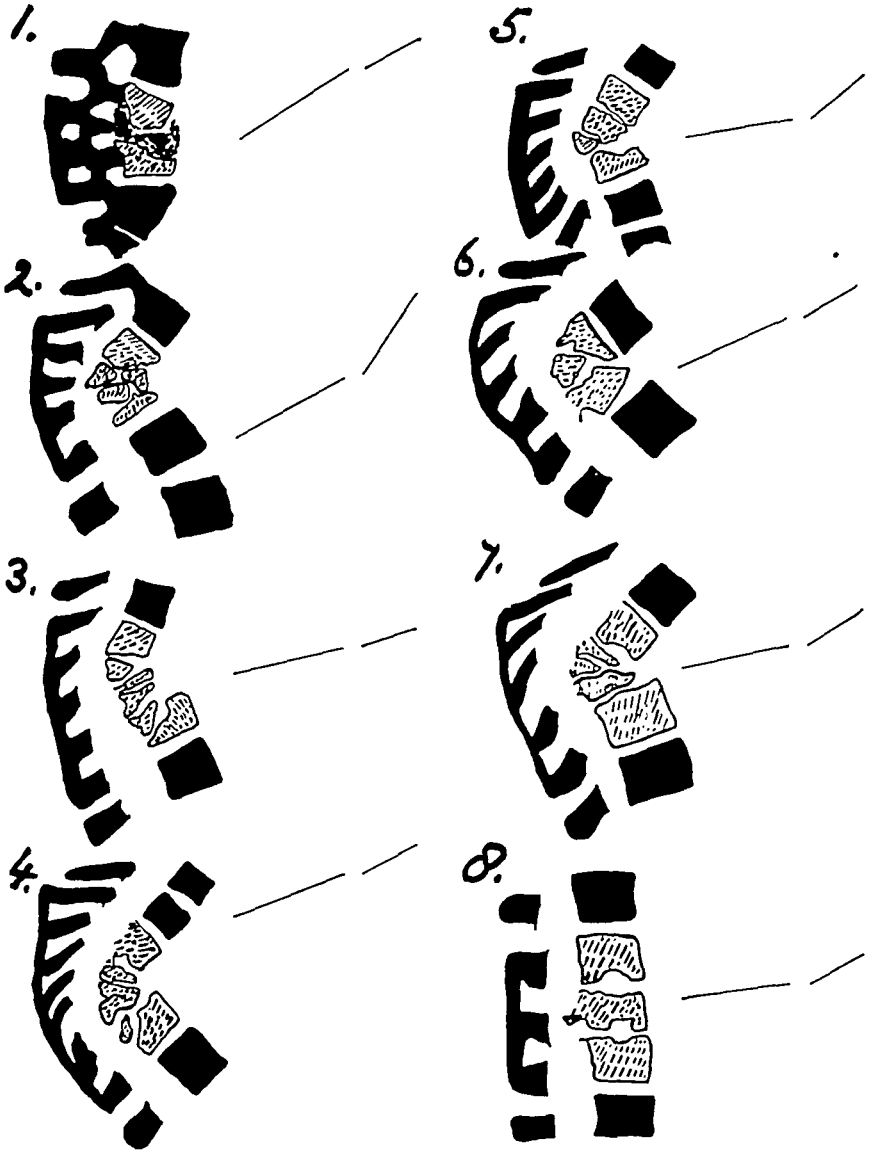



FIG. 6

Schematic drawings of the spines of eight children. The curve beside each sketch shows the increase in body weight a year before the operation and after the operation. (*Courtesy of Nederlandsch Tijaschrift voor Geneeskunde.*)

than with the short bone graft, but motion of the vertebrae, grown to one functional unit after the spondylodesis, should not be considered as harmful, for the movements take place in the normal intervertebral discs and joints above and below this unit.

Figures 3 and 4 show a boy suffering from tuberculosis of the second, third, and fourth lumbar vertebrae. On admittance to the Hospital, the back was quite rigid and did not permit the patient to lean forward very

much, because of the total fusion of the lumbar spine by a long bone graft. Figure 5 shows the same boy after the superfluous part of the long graft had been removed.

The short bone graft is based on a different principle; it is employed as a final procedure of conservative treatment.

Every case of tuberculosis of the spine, in children as well as in adults, should be treated conservatively at first. The usual general treatment should be combined with absolute recumbency in a plaster bed for several years. The final spondylodesis, which is done in certain cases, is only to be considered as a safety-lock to reenforce a healed condition. After the operation, the patient remains in a plaster bed for about six months and is gradually mobilized in a light, reenforced, celluloid jacket. As a matter of fact, the spondylodesis not only influences the local part of the spine, but it even improves the general condition.

Figure 6 shows the spines of the first eight children operated upon by the author. The curve beside each of the schematic drawings shows the increase in body weight a year before the operation and a year after the operation; the initial drop following the operative procedure is not recorded. With the exception of the first and third cases, there is a remarkably rapid increase in weight after the operation.

These absolutely objective observations are very important, and the early results of the operation warrant its further use.

# ENLARGEMENT OF THE LIGAMENTUM FLAVUM

## A Cause of Low-Back Pain with Sciatic Radiation *

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Enlargement of the ligamentum flavum producing compression of nerve roots is a more common cause of low-back pain with sciatic radiation than has been recognized. During the past seven months, seven patients with such symptoms have been proved at operation to have enlargement of the ligamentum flavum. Relief followed operation.

Few reports of this condition have appeared in the literature and little attention has been accorded them. The earliest report which the writer has been able to find is that by Elsberg in 1913. This was a typical case of compression of the nerve root following trauma. An enlargement of the ligamentum flavum was found at operation and complete relief of symptoms followed its removal. In 1916, the same author mentioned briefly two cases of enlarged ligamentum flavum. In 1931, Towne and Reichert reported two cases without antecedent trauma. An article by Puusepp appeared in the Esthonian literature in 1932, reporting three cases, in two of which trauma might have been a factor. In 1936, Abbott reported one traumatic case with recovery after operation. In the same year, Hampton and Robinson mentioned a case in an article on the roentgenographic findings in rupture of the intervertebral disc. Spurling, Mayfield, and Rogers have recently reported seven similar cases with relief of symptoms following operation.

During the past few years we have learned that rupture and dislocation of a portion of an intervertebral disc is a rather common cause of low-back pain with sciatic radiation. The history and symptoms of patients with enlarged ligamenta flava are essentially the same, and clinical differentiation between these two conditions is extremely difficult or impossible. In many instances, too, these syndromes cannot be differentiated clinically from lumbosacral or sacro-iliac disorders, and careful study is required before a diagnosis can be reached.

A history of trauma, usually of relatively slight degree, is common. This was true in six of our seven patients. The most frequent history of injury was of lifting, in association with flexion and torsion of the spine, or a fall on the buttocks. The patient usually described a snapping sensation in the spine followed by pain low in the back and, later, gradual radiation of the pain over the sciatic distribution into the thigh, the leg, and the foot. The interval between the onset of pain in the back and radiation into the leg varied from a few hours to several months. The

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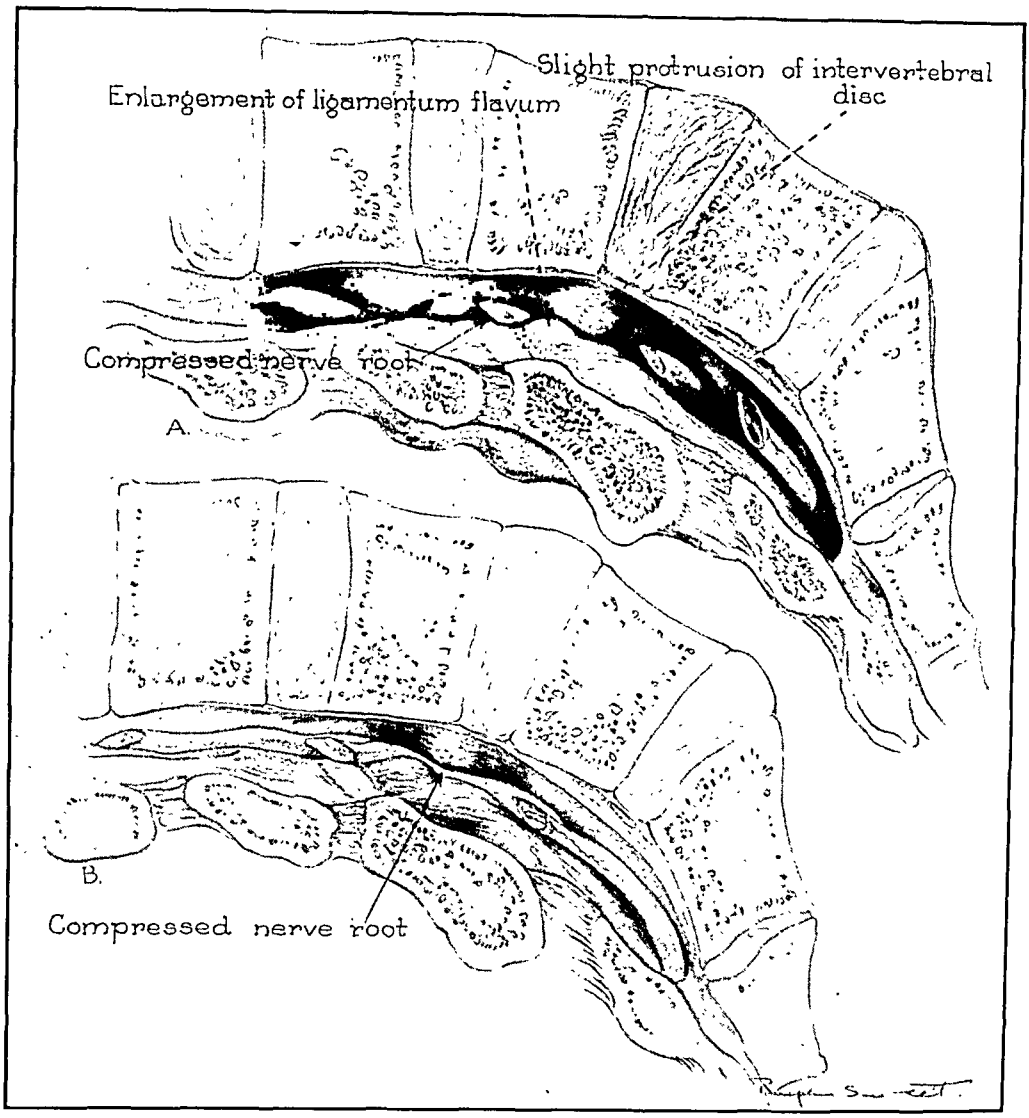



FIG. 1

Sagittal section of the lumbosacral spine. This drawing was made from a specimen with an enlarged ligamentum flavum to show the mechanism of compression of the nerve root. The dura has been removed.

*A:* Lateral view.

*B:* The specimen has been rotated to demonstrate the point of compression of the nerve root.

pain was usually severe and often disabling. In patients with enlargement of the ligamentum flavum, sensory disturbances—numbness and paraesthesia—may be present, and there is likely to be some degree of motor weakness in the involved extremity. In a small percentage the sphincters may be affected. The symptoms are usually unilateral, but may be bilateral if the encroachment on the spinal canal is of sufficient extent. Weight-bearing almost always aggravates the symptoms, and rest in a recumbent position may afford some degree of relief.

Objectively, the most common findings in our patients were some degree of scoliosis with a list to the unaffected side, a general restriction of movements of the back, and limitation of straight-leg raising on the involved side. Local tenderness over the lumbar spine was present, but

was seldom severe. Some motor weakness was usually found, most often in the anterior tibial muscles. The most constant single finding was a decrease in the Achilles-tendon reflex on the side of the lesion. Sensory disturbances of varying degree were present over the buttocks, the posterior aspect of the thigh, the calf, and the foot. The most common sensory alteration appeared over the outer aspect of the lower part of the leg and the dorsum of the foot.

Plain roentgenograms of the spine showed no pathological change in the bones or the joints and were of little value.

A positive diagnosis of enlargement of the ligamentum flavum can seldom be made from a clinical study alone. Spinal puncture and the use of lipiodol are required. An increase in the total protein content of the spinal fluid above fifty milligrams per 100 cubic centimeters, suggestive of an intraspinal pathological process, was present in three of the four cases in which this determination was made. The Wassermann reactions were negative in all seven cases. At least four cubic centimeters of lipiodol should be used in order to locate a minor defect in the spinal canal. Roentgenographic examination should be made with the patient in the prone position and any defects should be checked by immediate films, without moving the patient. In the absence of abnormalities, the examination should be repeated after an interval of two weeks, to be certain that a defect has not been overlooked.

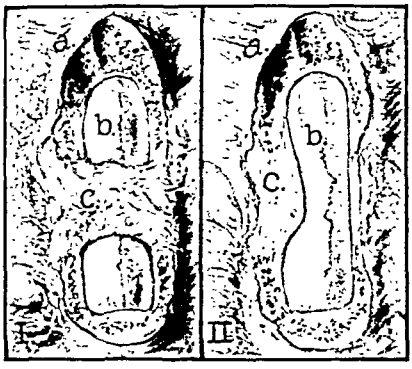



FIG. 2

Drawing made at operation after removal of the lamina.

*I:* View before removal of the ligamentum flavum: *a*, laminal margin; *b*, dural sac; *c*, enlarged ligamentum flavum intact.

*II:* View after removal of the dorsal portion of the ligament: *a*, laminal margin; *b*, dural sac; *c*, unilateral enlargement of the ligamentum flavum.

The enlargement of the ligaments occurred between the fourth and fifth lumbar vertebrae in six of our patients and at the lumbosacral junction in one.

Study of the anatomy of the ligamenta flava shows that even a moderate enlargement may cause compression of the nerve roots. These ligaments arise from the dorsal and upper margins of each lamina, pass upward beneath the lamina immediately above, and enter the neural canal. They fuse in the mid-line and laterally have expansions which extend well down toward the anterolateral aspects of the neural canal and form the posterior margins of the intervertebral foramina. The ligaments lie in close association with the articular facets in the neural canal and, to some degree, form a capsular covering for the articulations. Directly below each ligament lies the intervertebral disc, and the very narrow space between them serves as a passage for the nerve root after it

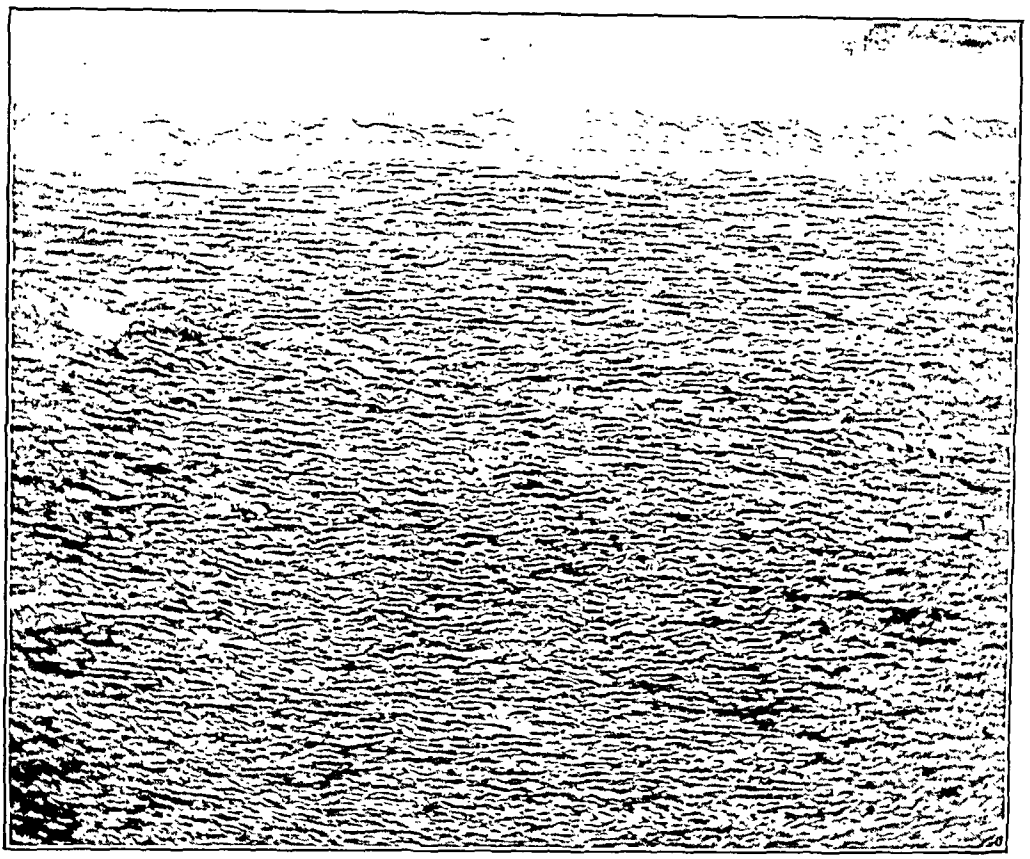


FIG. 3

Photomicrograph of normal ligamentum flavum.

emerges from the dural canal. An increase in the size of the ligament, a posterior protrusion of the disc, or a combination of the two, serves to compress the nerve root at this point (Fig. 1). Enlargement of the ligament may be generalized, although sometimes it is unilateral (Fig. 2), and it probably results from two factors,—namely, injury and scar tissue. Normal ligaments are composed entirely of yellow elastic fibers (Fig. 3) and grossly have considerable elasticity. Even at necropsy, however, we have observed a bulbous expansion of the ends of the ligaments when they have been torn during removal. It seems likely that at the time of the injury—whether minor or severe—rupture of some of the elastic fibers of the ligamenta flava occurs, allowing them some degree of expansion. Subsequently, as repair takes place, scar tissue is formed with further enlargement of the ligaments, so that compression of the nerve roots may result. Such injury and replacement by scar tissue can be demonstrated microscopically after the surgical removal of the enlarged ligament (Fig. 4). Sections should be made a short distance from the points of attachment to the bone, so that normal fibrous tissue at these points will not be mistaken for scar tissue in the ligament.

Treatment consists of laminectomy and a wide lateral removal of the enlarged ligament in order to free the nerve root from compression. As the lamina is removed, the ligament is seen immediately beneath it and,



FIG. 4

Case 1. W. F. L. Photomicrograph demonstrating the typical fibrotic scarring and marked degeneration and derangement of the yellow elastic fibers.

if the enlargement is generalized, the constriction of the dural sac is often striking. Normally the ligaments in the lumbar region are from two to three millimeters in thickness, but, in the more marked enlargements, they have measured as much as one centimeter. The majority are not adherent to the dura, but in one instance (Case 7) the ligament was firmly bound down to it. No changes were noted in the laminae overlying the enlarged ligaments. In all cases a careful search was made to determine the possible presence of a ruptured intervertebral disc. In two cases, a very small prominence of the disc was found in association with the enlarged ligamentum flavum. These did not amount to real dislocations of the intervertebral disc and, alone, would not have been sufficient to produce compression of the nerve roots. Any undue prominence of the disc, however, serves to decrease the size of the passage for the nerve root (Fig. 1), so that even a moderate enlargement of the ligament would compress the root against it.

Ordinarily the laminae are removed by rongeurs and the ligamenta flava are often removed with the bone. Consequently it would be possible to overlook an enlargement of the ligament and feel that no lesion had been present. It is likely that such a removal of an enlarged ligamentum flavum explains certain cases in the past in which definite defects had been shown by the injection of lipiodol, but nothing was found at

operation to explain them. Nevertheless the symptoms were relieved after operation because of the decompressive effect of the laminectomy and of the simultaneous removal of an unsuspected enlarged ligamentum flavum.

In most of our patients rapid relief of pain followed removal of the ligament. If the compression of the nerve root had been prolonged and severe, recovery from the alterations in sensation, motor power, and reflexes was gradual, as is the case in the recovery and regeneration of any peripheral nerve following trauma.

## REPORT OF CASES

*Case 1.* A fall on the buttocks was followed by low-back pain with unilateral sciatic radiation of seven months' duration. The spinal fluid showed an increased protein content and roentgenographic examination demonstrated a defect in the column of lipiodol at the lumbosacral junction. Removal of an enlarged ligamentum flavum gave relief of symptoms.

W. F. L., male, twenty-six years of age, was seen first in September 1936. On July 26, 1936, the patient had slipped, landing with considerable force on the buttocks. There was no immediate complaint, but on the following day he noted an aching pain in the right buttock, with slight discomfort down the posterior aspect of the thigh. There was a gradual increase in the severity of the pain and it was aggravated by activity. Rest in a recumbent position afforded complete relief of symptoms. The patient was treated by heat, massage, and supportive measures, without improvement in the symptoms.

Examination was made on September 5, 1936. There was great limitation of forward bending, restriction of straight-leg raising on the right side to 45 degrees, and moderate tenderness of the sciatic nerve at the sacrosciatic notch. No muscle atrophy was present. The right Achilles-tendon reflex was decreased and some hypaesthesia was present over the posterior portion of the thigh and the posterolateral aspect of the lower extremity. Roentgenograms of the lumbosacral spine were negative. An injection of the sacral hiatus with normal salt solution gave temporary relief, but the symptoms gradually recurred with persistence of the same findings. In January 1937, spinal puncture was done; the hydrodynamics of the spinal fluid were normal; the total protein content was ninety-seven milligrams per 100 cubic centimeters. Injection with lipiodol and fluoroscopic studies demonstrated a constriction in the dural sac at the lumbosacral junction (Fig. 5). This was interpreted as representing a dislocation of an intervertebral disc.

Laminectomy was performed on February 17, 1937, and an enlarged ligamentum flavum was found constricting the dural sac at the lumbosacral junction. It was removed widely on both sides. Careful exploration showed no other pathological process. Great scarring of the ligament, with destruction and fragmentation of the elastic tissue, was shown by microscopic examination. The patient was immediately relieved of pain by the operation. His only residual complaint was an occasional slight sensation of numbness in the left leg upon undue activity. Motor power, sensation, and reflexes rapidly returned to normal.

*Case 2.* Low-back pain with unilateral sciatic radiation for thirteen months followed an indefinite injury to the back. Examination with lipiodol was only suggestive of a defect between the fourth and fifth lumbar vertebrae. Removal of an enlarged ligamentum flavum (unilateral) was followed by improvement.

N. H., male, twenty-eight years of age, a bookkeeper, entered the hospital on August 24, 1936, complaining of pain low in the back on the left side, with typical sciatic radiation into the left lower extremity. The patient had first noticed pain in the back six months prior to entry, particularly after long automobile drives. Three months later, after spading, the pain had radiated down the posterior aspect of the left lower extremity, extending into the calf and the ankle. Following this, flexion or rotation of the spine aggravated the pain. The left leg tired easily. Very little relief was obtained by rest in bed. The only history of injury in this case was of an automobile accident a year before entry, but no definite injury to the patient's back was noted at the time.

There was marked bilateral limitation of straight-leg raising; the left gluteal muscles were somewhat flabby; the power of the left leg was approximately equal to that of the right. The left patellar-tendon and Achilles-tendon reflexes were less active than the right. No sensory disturbance was noted. Jugular compression produced pain in the left leg. Roentgenographic examination showed six lumbar vertebrae with sacralization of the last segment. Spinal puncture caused an unusual amount of pain when the needle compressed the dura; the hydrodynamics of the spinal fluid were normal. Lipiodol was injected, but fluoroscopic studies were negative.

The patient was treated by manipulation and traction, without relief. Six weeks later, the fluoroscopic studies were repeated and were suggestive of a defect at the level between the fourth and fifth lumbar vertebrae on the left. In view of the persistent symptoms, the positive neurological findings, and the failure to obtain relief by conservative measures, laminectomy was decided on and was done on March 10, 1937. A moderate enlargement of the ligamentum flavum was found on the left side between the fourth and fifth lumbar vertebrae. Careful search of the canal showed no evidence of a ruptured intervertebral disc. On microscopic examination of the enlarged ligament, damage to the elastic tissue and replacement by scar were found, as shown in Figure 4. The patient had much less pain after operation, although he was not entirely relieved



FIG. 5

Case 1. W. F. L. The use of lipiodol demonstrates a defect at the lumbosacral junction.



FIG. 6

Case 3. J. G. There is a slight defect in the column of lipiodol between the fourth and fifth lumbar vertebrae on the left.




FIG. 12

Case 4. Preoperative spine-marker roentgenogram, with patient in wedging jacket.

hiatus with novocain seemed to aggravate the pain. Numbness appeared over the outer aspect of the lower part of the left leg and the patient began to notice weakness of the anterior tibial muscles.

Examination was done on March 12, 1937. There was no tenderness in the lower part of the back. Forward bending was markedly restricted and straight-leg raising on the left was limited to 25 degrees; no atrophy was present; power in the anterior tibial muscles was considerably lessened. There was a decrease in sensation along the lateral side of the leg and the dorsum of the foot. The left Achilles-tendon reflex was absent. Roentgenograms of the lumbosacral region showed no signs of trauma. The hydrodynamics of the spinal fluid were normal. Lipiodol demonstrated a very marked constriction of the meningeal sac between the fourth and fifth lumbar vertebrae (Fig. 7). An enlarged ligamentum flavum was suspected before operation in this case.

Laminectomy was done on April 15, 1937, and an unusually large ligament was found, producing a uniform constriction of the dural sac and its contents on both sides. An extensive removal was done, care being taken that the lateralmost part of the ligament was removed. The fifth lumbar root on the left was swollen. No evidence of a ruptured intervertebral disc was found. A spinal fusion was done following laminectomy.

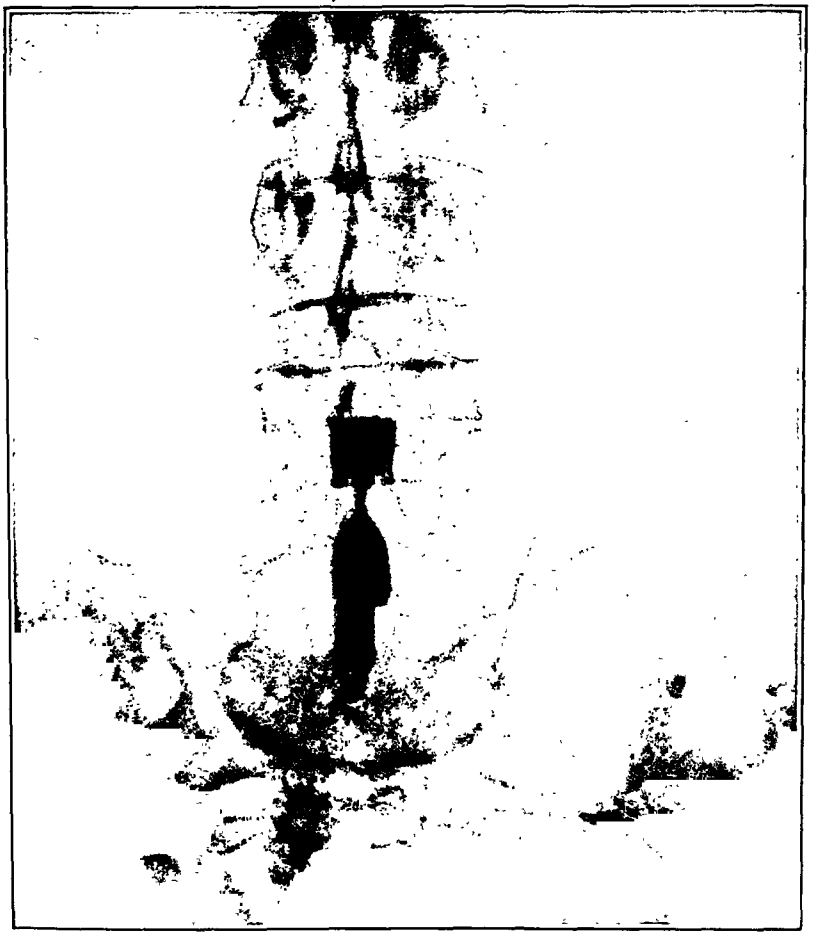


FIG. 7

Case 4. T. O'C. There is a uniform constriction of the dural sac between the fourth and fifth lumbar vertebrae.

of it. He returned to work about six weeks after operation and has continued to perform his regular duties. Straight-leg raising has greatly improved and, at the present time, there is no evidence of motor, reflex, or sensory change. The residual discomfort in this case may be explained by a failure to remove the ligament sufficiently far laterally to decompress the nerve root completely near the intervertebral foramen.

*Case 3.* Low-back pain with unilateral sciatic radiation of five months' duration occurred after torsion of the spine. The protein content of the spinal fluid was increased and lipiodol showed a unilateral defect between the fourth and fifth lumbar vertebrae. An enlarged ligamentum flavum (unilateral) was removed and a prominent intervertebral disc was found behind the nerve root. Complete relief of signs and symptoms followed operation.

J. G., male, twenty-four years of age, entered the hospital in March 1937. In October 1936, the patient had leaned inside an automobile to wipe a windshield. He noted a snapping sensation in the lower part of the back and complained of pain low in the back immediately thereafter. Five days later the pain radiated over the sciatic distribution into the left lower extremity. When the patient was recumbent, the pain subsided, but it recurred immediately on weight-bearing. He had noted no numbness or motor weakness.

Examination on January 13, 1937, showed no spasm of the muscles low in the back, although there was tenderness between the fourth and fifth lumbar vertebrae. Jarring, at this point, produced some degree of pain in the left leg. No muscle atrophy was present, but there was slight weakness of the left extensor hallucis longus. Sensation was normal; the left Achilles-tendon reflex was decreased. Roentgenographic examination of the lumbosacral region was negative. Spinal puncture was done, showing normal hydrodynamics of the spinal fluid; the total protein was fifty-seven milligrams per 100 cubic centimeters. Lipiodol studies under the fluoroscope demonstrated a very slight defect between the fourth and fifth lumbar vertebrae on the left side (Fig. 6). The defect was so slight that further conservative measures were tried. Traction gave temporary improvement, but weight-bearing immediately brought on pain low in the back and in the leg.

Laminectomy was performed on March 15, 1937. The ligamentum flavum on the left side was enlarged and the increase in size was most evident in the lateral portion adjacent to the fifth lumbar root. Following the removal of the enlarged ligament, inspection behind the root showed a very slight prominence of the intervertebral disc at that point. This prominence, in itself, would not have produced symptoms, but the combination of the enlarged ligament and the prominence of the disc undoubtedly did cause them. The patient's pain was immediately relieved, and the reflexes gradually returned to normal. He went back to his regular work about two months after operation and has had no recurrence of pain.

*Case 4.* A fall on the buttocks preceded low-back pain with unilateral sciatic radiation of fourteen months' duration. Lipiodol demonstrated a generalized constriction of the dural sac. An enlarged ligament was removed, with relief of pain and gradual improvement in the motor and sensory loss.

T. O'C., male, fifty-five years of age, was injured on February 29, 1936, when his left foot slipped into a pit and he dropped sharply to the ground, striking the buttocks. He had immediate pain low in the back, which persisted in spite of constant treatment. It was not until August 1936 that he first began to have radiation of pain over the distribution of the left sciatic nerve, extending to the ankle. A manipulation at this time resulted in temporary improvement. Later, an injection of the sacral

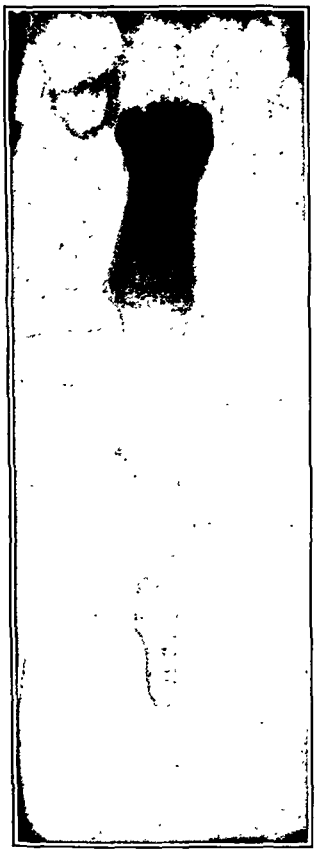


FIG. 9

Case 6. S. A. Anteroposterior roentgenogram showing the marked constriction of the dural sac between the fourth and fifth lumbar vertebrae.

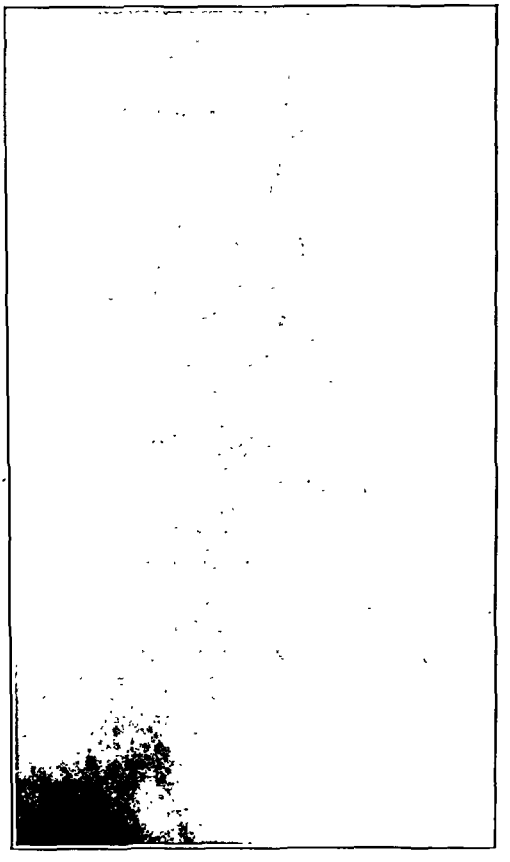


FIG. 10

Case 6. S. A. Lateral view.

This prominence, in itself, was not sufficient to produce the degree of compression which was found.

The patient has had considerable relief of pain. He has occasional paraesthesia in the area of altered sensation and the right Achilles-tendon reflex is still below normal. Epicritic sensibility is improving. His activity is being increased gradually. When one considers the duration and severity of compression of the spinal root, progress has been satisfactory.

*Case 6.* Low-back pain with bilateral sciatic radiation followed a direct injury to the back, and a subsequent increase in symptoms occurred after flexion of the spine. The protein content of the spinal fluid was increased. Lipiodol showed a general constriction of the dural sac. A generalized enlargement of the ligament was found at operation and relief was rapid after its removal.

S. A., male, forty-two years of age, was buried up to his chin in a cave-in of dirt in March 1936. Immediately following his release he noted pain low in the back, which persisted. He attempted to continue his work and one month later, while bending over, had a sudden snapping sensation low in the back, with an increase in pain. The pain then radiated down the posterior aspects of both legs, forcing him to stop work in August 1936. The legs became weak and the patient was unable to stand. He was

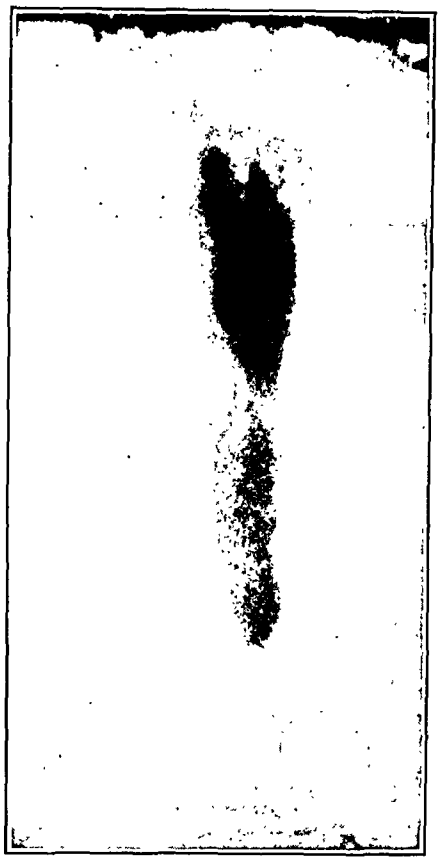


FIG. 8

Case 5. S. C. There is a slight defect between the fourth and fifth lumbar vertebrae.

Microscopic examination of the ligament showed a fragmentation of the elastic fibers with an increase in connective tissue. The pain was relieved immediately and the patient is increasing his activities steadily. There is still some residual sensory decrease and the left Achilles-tendon reflex has not yet returned to normal.

*Case 5.* The patient had experienced low-back pain with unilateral sciatic radiation after a direct injury to the spine during the act of lifting; this pain had persisted for twenty-three months. Lipiodol demonstrated a unilateral defect between the fourth and fifth lumbar vertebrae. An enlarged ligament and a prominent intervertebral disc were found at operation. Improvement has been gradual.

S. C., male, thirty-seven years of age, while lifting a packing case on May 28, 1935, had slipped and fallen backward, striking his back against a hard object. He had immediate pain low in the back, chiefly on the right side and extending into the right hip. The pain radiated down the posterior aspect of the right leg. The leg felt somewhat numb and heavy, and the patient experienced some difficulty in motor control. Conservative measures, such as heat and rest, were tried without improvement. In January 1936, because of the continuation of symptoms, the transverse process of the fifth lumbar vertebra was removed. No improvement followed; in fact the patient believed that the pain and weakness of the right lower extremity were gradually increasing.

Examination on August 4, 1936, showed no spasm of the muscles low in the back; movements of the back were performed fairly well in all directions. Straight-leg raising on the right side showed only slight limitation. The right thigh was two inches less in circumference than the left, and the right calf one and five-eighths inches smaller than the left. The patient had had a compound fracture of this leg with involvement of the common peroneal nerve, which accounted for some of the atrophy. Motor power was generally decreased in the right leg. The anterior tibial muscles were much weaker in proportion than the others. The right Achilles-tendon reflex was decreased. Some sensory decrease was present on the lateral and posterior aspects of the right lower leg. Roentgenographic examinations were negative except for the absence of the transverse process removed at operation. The patient was reëxamined on March 24, 1937, with essentially the same findings; his complaints had not changed. The hydrodynamics of the spinal fluid were normal; the total protein was forty-five milligrams per 100 cubic centimeters. Injection of lipiodol demonstrated a slight defect between the fourth and fifth lumbar vertebrae, suggestive of rupture of an intervertebral disc (Fig. 8).

Laminectomy was done on April 24, 1937, and an enlarged ligamentum flavum was found between the fourth and fifth lumbar vertebrae. The enlargement was more pronounced on the right side. A wide removal of the ligament, including its lateral portion, exposed the fifth lumbar root which was swollen. The intervertebral disc ventral to this root was slightly prominent, but inspection of the area showed no real dislocation.

R. P., male, fifty years of age, a physician, had begun to have lumbar backache and to suffer occasional attacks of acute pain in 1929. This pain had been aggravated by movement and relieved by rest in bed. In January 1930, he had had a recurrence of severe backache with left sciatic pain. During the next four years he had assumed an abnormal posture in order to reduce the frequency and severity of pain. In March 1935, he had had a severe attack of pain with radiation down the outer aspect of the left leg into the ankle. Another attack had occurred in December 1936.

Examination was made in January 1937. The left leg was colder than the right. Hyperhidrosis was noted from the toes to the middle of the calf on the left. Coughing, straining, and sneezing aggravated the pain. When examined again on July 28, 1937, the left leg was still cold, and pulsation of the left dorsalis pedis artery was absent. These indicated some coincidental vascular disturbance. Power in the left leg was markedly decreased, particularly with reference to dorsiflexion of the left foot and great toe. The left patellar-tendon and Achilles-tendon reflexes were slightly more active than the right. The left calf was a little smaller than the right. There was a painful hypaesthesia over the dorsum of the left foot and the anterolateral aspect of the lower leg, and areas of hypaesthesia were present in both calves. The hydrodynamics of the spinal fluid were normal. Lipiodol studies demonstrated a filling defect of the dural sac on the left side between the fourth and fifth lumbar vertebrae (Fig. 11).

Laminectomy was done on August 9, 1937. An enlargement of the ligamentum flavum was found, and the ligament was densely adherent to the dura. The fifth lumbar root on the left was somewhat adherent and its dural sheath was encompassed by scar tissue. Microscopic examination of the ligament demonstrated the fibrotic scarring and marked degeneration and derangement of the yellow elastic fibers common to this condition. The patient has had relief from pain, but it is too soon after operation to expect much alteration with regard to power, sensation, and reflexes.

## COMMENT

Although sufficient time has not elapsed to permit a report on the end results in all of our patients, there has been relief from severe pain in all, and improvement has been continuous to the present time. It is evident also that early diagnosis and operative treatment, before compression of the nerve roots has been prolonged, will undoubtedly produce more rapid and complete recovery.

Obviously lipiodol studies should not be resorted to in all patients who have low-back pain with sciatic radiation. A thorough trial of conservative measures is indicated unless increasing evidences of neurological involvement are present. All of our patients had been treated previously by conservative orthopaedic measures, and lipiodol studies were undertaken because of persistent signs and symptoms in spite of treatment.

## SUMMARY

Enlargement of the ligamentum flavum is a clinical entity producing low-back pain with sciatic radiation. Trauma of relatively slight degree was the etiological factor in the majority of our patients. Pathological changes in the involved ligaments were demonstrated microscopically.

The clinical syndrome is difficult to differentiate from lumbosacral or sacro-iliac disorders, and lipiodol studies are required in order to reach a final diagnosis. It is seldom possible to differentiate the defects in

placed in traction which seemed to give some temporary improvement, although the symptoms again became worse on weight-bearing.

Examination was done on March 29, 1937. The patient complained of severe pain low in the back with radiation to both hips and occasional shocklike pains in both legs. The entire lumbar spine was hypersensitive and movements of the back were greatly restricted in all directions. The patient walked with a guarded gait, favoring the right leg. No muscle atrophy was present in either leg. There was motor weakness of all muscles in both lower extremities, most pronounced on the left. Pain inhibited some muscle movements. There was a slight decrease in sensation over the right buttock. The right patellar-tendon and Achilles-tendon reflexes were more active than the left. Roentgenograms of the lumbosacral region were negative. Spinal puncture showed normal hydrodynamics of the spinal fluid; the total protein was 110 milligrams per 100 cubic centimeters. Lipiodol studies demonstrated a marked obstruction between the fourth and fifth lumbar vertebrae (Figs. 9 and 10). A small amount of lipiodol passed down along the right side of the dural sac.

Laminectomy was done on May 7, 1937. The ligamentum flavum in this case was the most enlarged in our series,—it measured slightly over one centimeter in thickness. The dural sac and its contents were greatly constricted by the enlarged ligament and, even after removal of the ligament, the dural sac was found to be partly constricted, as was the underlying arachnoid. A spinal fusion was done following the laminectomy. Microscopic examination of the ligament showed areas in which the yellow elastic fibers were fragmented and replaced by fibrous connective tissue. A few areas of perivascular lymphocytic infiltration were seen. The patient was immediately relieved of pain and has been up and about without a recurrence of symptoms. His activity is gradually being increased and his progress has been satisfactory.

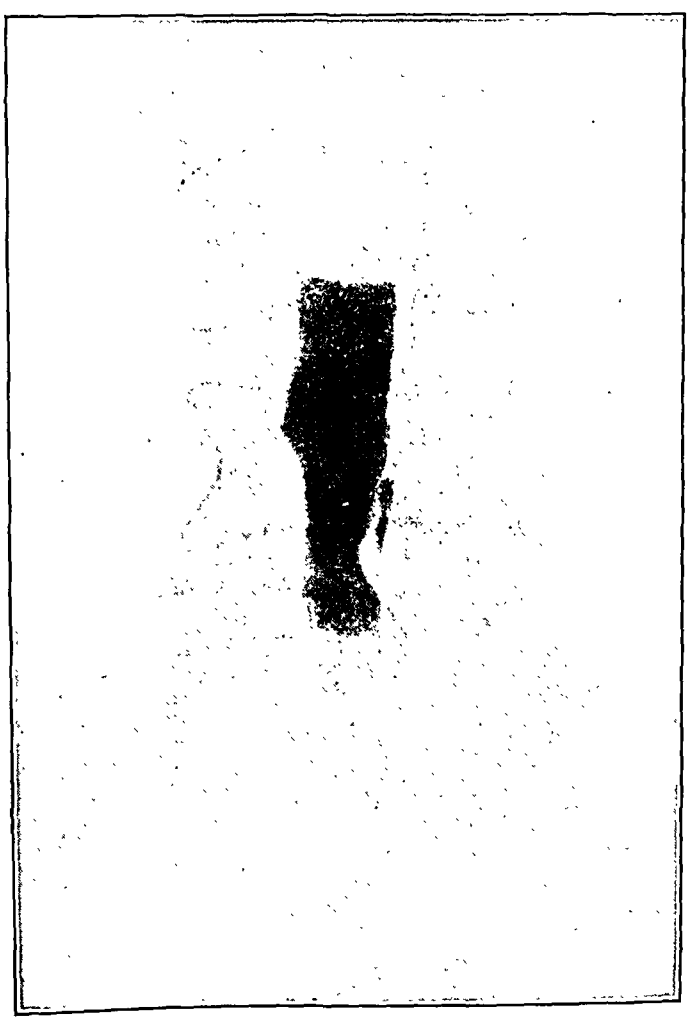


FIG. 11

Case 7. R. P. There is a defect in the column of lipiodol between the fourth and fifth lumbar vertebrae on the left.

*Case 7.* Low-back pain with unilateral sciatic radiation was present for eight years. There was no antecedent trauma. Lipiodol demonstrated a unilateral defect between the fourth and fifth lumbar vertebrae. An enlarged ligament, adherent to the dura, was removed at operation, with relief of pain.

# A PROCEDURE FOR THE CORRECTION OF INTERNAL ROTATION OF THE THIGH IN SPASTIC PARALYSIS *

BY HERBERT A. DURHAM, M.D., SHREVEPORT, LOUISIANA

Those surgeons who have had much experience with the treatment of spastic cerebral paralysis are familiar with the numerous and diverse problems that arise when the correction of associated deforming contractures is undertaken. That these problems have not all been satisfactorily solved is shown by the wide variety of suggested operations for the correction of these contractures.

It is not the purpose of this article to discuss spastic contractures in general, but, rather, to deal with a specific contracture which, in the experience of the writer, has for a long time been recognized as disabling and difficult to overcome,—namely, internal rotation of the thigh. Numerous devices and procedures have been instituted to correct this deformity with heretofore unsatisfactory results.

While internal-rotation deformity may exist in the absence of other contractures around the hip, it is by far more frequently associated with the commonly found flexion-adduction contractures of the thigh, and, thus effectively masked, it does not become manifest to its full extent until the flexion and adduction have been corrected. Even then it may escape notice when the patient is recumbent, but when he stands it will be observed that one or both thighs rotate inward and flex slightly at the hip and the knee. This position interferes greatly with locomotion and renders the gait clumsy and unsightly.

The apparent cause of this was brought to the author's attention several years ago by a patient, who, after release of the flexors and adductors of the thigh and lengthening of the hamstrings, exhibited an unusual degree of internal rotation of the thigh both in recumbency and when standing. Upon attempting to passively rotate the thigh externally, it was noted that the internal rotators were extremely tense and spastic, preventing passive rotation to a neutral position. This prompted a careful anatomical study of patients in whom the correction of adductor and flexor

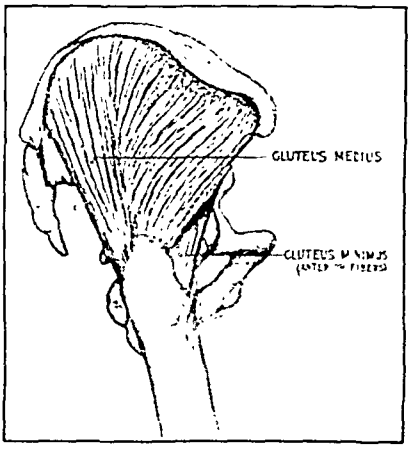



FIG. 1

Showing insertion of the gluteus medius and the gluteus minimus to the femoral trochanter.

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 18, 1938.

the column of lipiodol from those produced by rupture of an intervertebral disc. Compression of nerve roots by the enlarged ligament produces the symptoms and signs. After their exit from the dura, the nerve roots lie in the very narrow space between the ligamentum flavum and the intervertebral disc. Even a slight enlargement of the ligament, a posterior protrusion of the intervertebral disc, or a combination of the two, will produce compression of the nerve roots.

Seven patients with enlargement of the ligamentum flavum were operated on over a period of seven months. This would indicate that the condition is much more common than is supposed and that many such cases have undoubtedly been overlooked in the past. Operative removal of the enlarged ligament produced prompt relief of pain with gradual improvement in the impaired motor and sensory functions.

NOTE: The author is indebted to Dr. John Saunders of the Department of Anatomy for the use of the anatomical specimen in Figure 1.

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FIG. 13

Case 4. Three years after operation, with patient standing.

spasm had given disappointing results, and it was found that in practically all of those studied the same contracture or overactivity of the internal-rotator mechanism was present.

Of eighty-two patients with spastic paralysis admitted to the Shriners' Hospital for Crippled Children during the past six years, twenty, or approximately 25 per cent., had internal rotation of the thighs sufficient to interfere materially with walking. This indicates that spastic contracture of the internal rotators of the thighs is one of the common sequelae of spastic paralysis of the lower extremities.

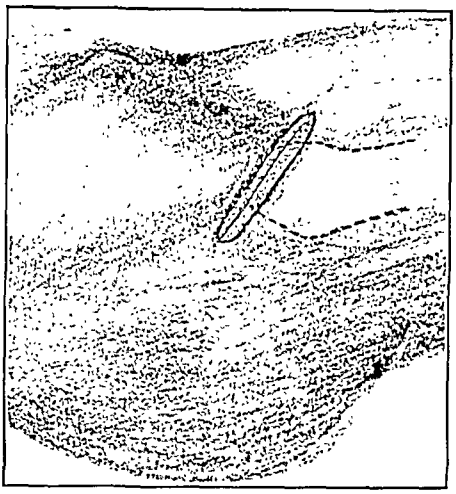


FIG. 2

Showing location of incision for release of internal rotators.

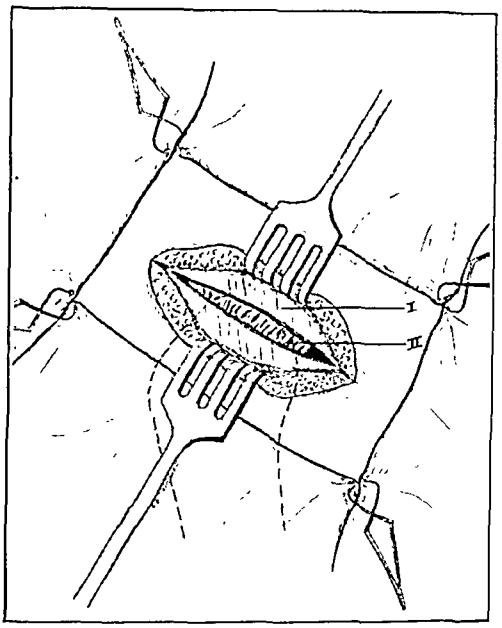



FIG. 3

*I:* Fascia lata divided in same line of skin incision.

*II:* Gluteus medius exposed.

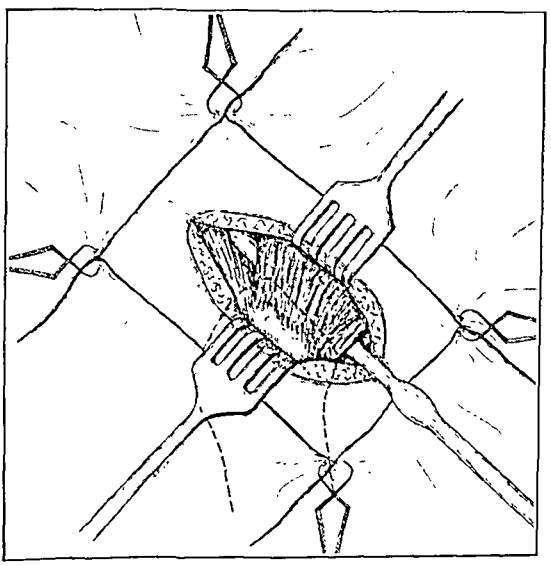


FIG. 4

Showing the portion of the gluteus medius and of the lower border of the gluteus minimus which is to be divided.

Since the anterior fibers of the gluteus medius and the gluteus minimus, assisted by the tensor fasciae femoris, constitute the effective internal-rotator mechanism of the thigh, it seemed logical to assume that a release of this mechanism would have a beneficial influence on the rotation deformity. Although the gluteus medius and the gluteus minimus are also the most important abductors of the thigh, it was reasoned that this action would not be seriously affected by a division of that part of the muscles which is attached anterior to the tip of

the greater trochanter, since the remaining superior fibers, still being spastic, would in all probability be sufficiently strong to maintain effective lateral balance of the pelvis in walking.

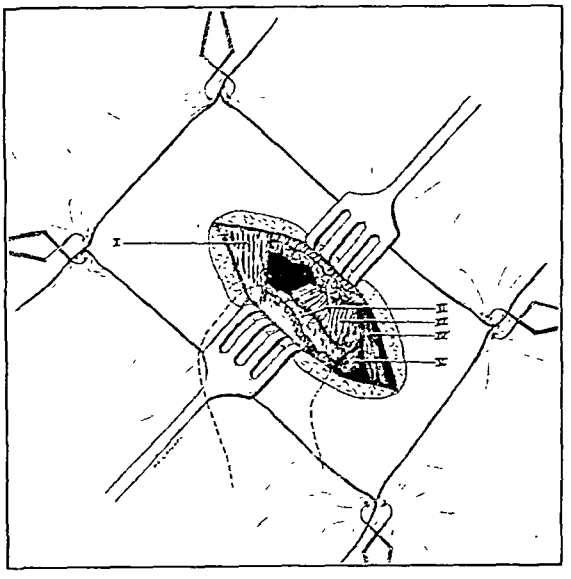



FIG. 5

*I:* Posterior fibers of the gluteus medius.
*II:* Cut anterior fibers of the gluteus medius and the gluteus minimus.
*III:* Capsule of the hip joint.
*IV:* Rectus femoris.
*V:* Iliopsoas.

### ANATOMICAL CONSIDERATIONS

As previously stated, the most powerful rotators of the thigh are the gluteus medius, the gluteus minimus, and the tensor fasciae femoris. The distal fibers of the adductor magnus and the iliopsoas are mentioned by some anatomists as assisting in internal rotation of the thigh, but, because of their location and attachment to the femur, their function, as such, is almost negligible, and they may be ignored as far as playing any part in the production of the deformity in question is concerned. The only true internal rotators of the thigh, then, are the gluteus medius, the gluteus minimus, and the tensor fasciae femoris, with the greater part of this function being carried out by the two gluteal muscles because of their direct insertion to the greater trochanter of the femur. In patients with pronounced internal rotation of the femur, the anterior portion of these muscles can be felt as heavy cords which stand out prominently when an attempt is made to passively rotate the femur externally.

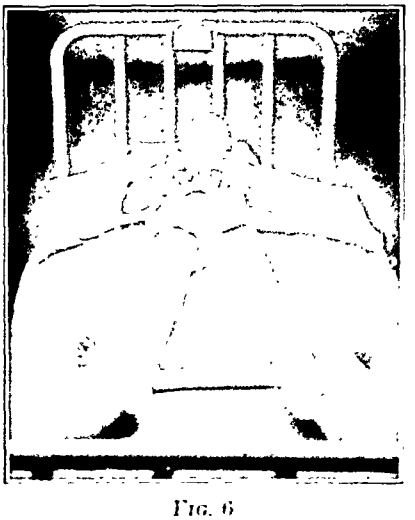


FIG. 6

Postoperative position of fixation in plaster.

The fan-shaped gluteus medius, arising from the dorsal surface of the ilium and from the fascia lata on its anterior surface, converges to the greater trochanter to be inserted by a strong short tendon into a well-marked diagonal line on its lateral



FIG. 7-A FIG. 7-B

Fig. 7-A: C. P., aged seven years. Before operation, showing characteristic internal rotation and adduction of the right thigh.

Fig. 7-B: C. P. One year after operation, showing complete correction of internal rotation.



FIG. 8-A FIG. 8-B

Fig. 8-A: F. T., aged ten years. Before operation, showing typical internal-rotation deformity of the right thigh.

Fig. 8-B: F. T. One year after operation, showing complete correction of internal rotation.

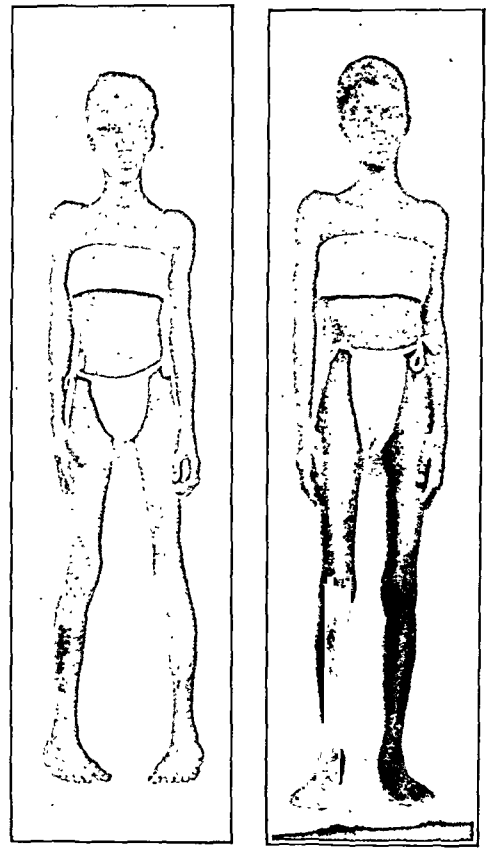


FIG. 9-A FIG. 9-B

Fig. 9-A: L. B., aged thirteen years. Before operation, showing typical bilateral internal rotation of thighs.

Fig. 9-B: L. B. Six months after operation, showing complete correction of internal rotation.

surface. (See Figure 1.) The gluteus minimus, also a fan-shaped muscle, arising under cover of the gluteus medius and from the dorsal surface of the ilium, converges to the anterosuperior angle of the greater trochanter and covers the superior aspect of the capsule of the hip joint. It is inserted into the anterosuperior surface of the greater trochanter. Both muscles are fairly superficial and readily accessible at their points of insertion, being covered only by skin, subcutaneous fat, fascia, and tensor fasciae latae.

## OPERATIVE TECHNIQUE

The operative technique for the release of these muscles is relatively simple. A short diagonal incision is made from behind forward immediately over the greater trochanter. (See Figure 2.) The tensor fasciae latae is divided in the line of the skin incision and retracted. (See Figure 3.) The gluteus medius and the gluteus minimus are exposed at their insertions into the greater trochanter. By rotating the thigh externally, one can put these muscles under tension, and they are thus easily identified. A grooved director or dissector is passed under that portion of the tendons which is inserted anterior and below the tip of the trochanter (Fig. 4). The tendons are then divided close to their insertions (Fig. 5). Any remaining tight fascial bands are easily detected by palpation and are likewise divided. The thigh can then be put into complete unresisted external rotation. If the fascia lata is tense and separates widely when the thigh is rotated outward, it is left unsutured and allowed to retract; otherwise it may be reapproximated. The subcutaneous fat and the skin are closed by separate layers of sutures.

Plaster immobilization is used to maintain the thigh in abduction and full external rotation. When the operation is unilateral, a single hip spica is sufficient. When the operation is bilateral, it is necessary to put on two long leg casts with a connecting bar to maintain the external rotation. (See Figure 6.) The casts are removed at the end of six or eight weeks, at which time physiotherapy and walking exercises are begun, provided the other necessary corrective procedures have been carried out.

It is conceivable that in extreme degrees of rotation of long duration there might exist some developmental shortening of the anterior portion of the hip capsule, particularly the iliotrochanteric and the iliofemoral portions of the Y-ligament. The author has never found this condition existing, but, should it be found, he sees no reason why the tight bands could not be safely divided.

## END RESULTS

During the past six years, twenty patients with this deformity have been operated upon. The internal-rotation contracture was bilateral in twelve patients, making the total number of operations thirty-two. The patients have been kept under observation for periods varying from six

months to six years. Thus far the correction has been maintained in all of the cases. There have been no disturbances of locomotion that could be attributed to gluteal weakness.

## SUMMARY AND CONCLUSIONS

1. Internal rotation of the thigh is a common, disabling, and persistent deformity in patients with spastic paralysis.

2. It is found mainly in conjunction with the more obvious flexor and adductor spasm, and for that reason its importance as a separate factor is apt to be overlooked.

3. The operation of anterior gluteal release is anatomically sound and technically simple.

4. Since it has given uniformly satisfactory results in a series of twenty patients, the writer has no hesitancy in presenting it as a helpful addition to the numerous surgical procedures in use for the relief of spastic contractures.

The author wishes to express his grateful appreciation and thanks to Dr. Gene D. Caldwell for the illustrative drawings and other valuable assistance in assembling the material.

# EXPERIMENTAL NON-CALCIFICATION OF CALLUS SIMULATING NON-UNION

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Complete bone repair is the outcome of two processes which usually concur,—callus formation and calcification. In this investigation we separated these two processes by experimental means, so that we were able to produce uncalcified callus. Although uncalcified callus did not show up in roentgenograms (the picture being that of non-union), histological studies revealed it to be bony in character, as did the fact that it precipitously calcified under a changed experimental procedure. Thus this experiment illustrates that complete bone repair can be prevented by the failure of the second process (calcification), and that the two processes concerned in bone repair are controlled by entirely different factors.

## MATERIAL AND METHODS

Twenty normal rats, four weeks old, were used in the experiment. These were fed Steenbock's rickets-producing diet consisting of 76 per cent. ground whole corn, 20 per cent. wheat gluten, 3 per cent. calcium carbonate, and 1 per cent. sodium chloride, plus 5 per cent. dried brewer's yeast. After the animals had lived on this diet for one week, they were anaesthetized and the right foreleg of each animal was broken. The fracture included both the radius and the ulna. After this procedure, the animals lived on the same diet for three weeks, when ten of them were killed, x-rayed, and autopsied. This group of animals will hereafter be called "Group A". The ten remaining animals were allowed to live four days longer, and in this period each received, in addition to the diet already outlined, about 75 international vitamin-D units in the form of viosterol. At the end of this time, they were killed, x-rayed, and autopsied. This group of animals will hereafter be called "Group B".

The two groups of animals were treated identically with the exceptions that the animals of Group B lived twenty-five days instead of twenty-one days and received vitamin D during the last four days of life.

The blood from the animals of each group was pooled for chemical examination. The right femora of the animals of each group were pooled for bone-ash estimations. The fractured foreleg of each animal was x-rayed, after which it was removed and fixed and decalcified in Bouin's fluid and sectioned by the paraffin method. Serial sections were prepared in many cases in order to obtain a comprehensive view of the fracture area. They were stained with hematoxylin and eosin.

## OBSERVATIONS

### *Chemical Findings*

The average values found for the calcium and inorganic phosphorus in the whole blood, as well as the percentage of ash in the leg bones of the animals, are given in Table I.

TABLE I

CHEMICAL FINDINGS

| | Blood Calcium (*Milligrams per 100 Cubic Centimeters*) | Blood Phosphorus (*Milligrams per 100 Cubic Centimeters*) | Bone Ash (*Per Cent.*) |
|---|---|---|---|
| Group A | 10.3 | 2.5 | 30.3 |
| Group B | 10.4 | 8.8 | 31.3 |

### *Roentgenographic Findings*

As may be seen in the two left-hand columns of Figure 1, roentgenograms of the ten fractures in the animals of Group A showed little evidence of callus. In only three of the ten fractures was any trace of callus seen, and seven of the ten fractures presented the picture of non-union.

The two right-hand columns of Figure 1 present the roentgenograms of the ten fractures in Group B. Seven of these showed good callus formation.

The difference between the typical x-ray appearance of animals of Groups A and B is apparent in Figures 2-A and 2-B which are enlargements of the original roentgenograms. Figure 2-A shows a typical fracture in Group A, while Figure 2-B shows a typical fracture in Group B.

### *Microscopic Findings*

Whereas the x-ray appearance of the fractures in Group A differed markedly from those of Group B, the sections of these fractures on microscopic examination proved to be strikingly similar. (See Figures 3-A and 3-B.) At the site of fracture in both groups there was excellent organic callus formation. The repair was not of the sort termed fibrous union, because the callus was composed of the same organic constituents that are seen in the repair of a normal fracture,—namely, osteogenic tissue, a certain amount of cartilage, a considerable amount of very young bone (usually termed "osteoid tissue"), and a certain amount of newly formed bone of a more mature appearance. If any difference existed in the microscopic appearance of the fractures in the two groups of animals, it was the tendency for the organic matrix in the calluses of the animals of Group B to stain somewhat more deeply with hematoxylin. (This phenomenon is usually considered indicative of calcification. We, however,

doubt the ability of hematoxylin to indicate very accurately the calcium content of tissues even when they are not decalcified, and we are completely skeptical of its ability to indicate sites of calcification in decalcified material.)

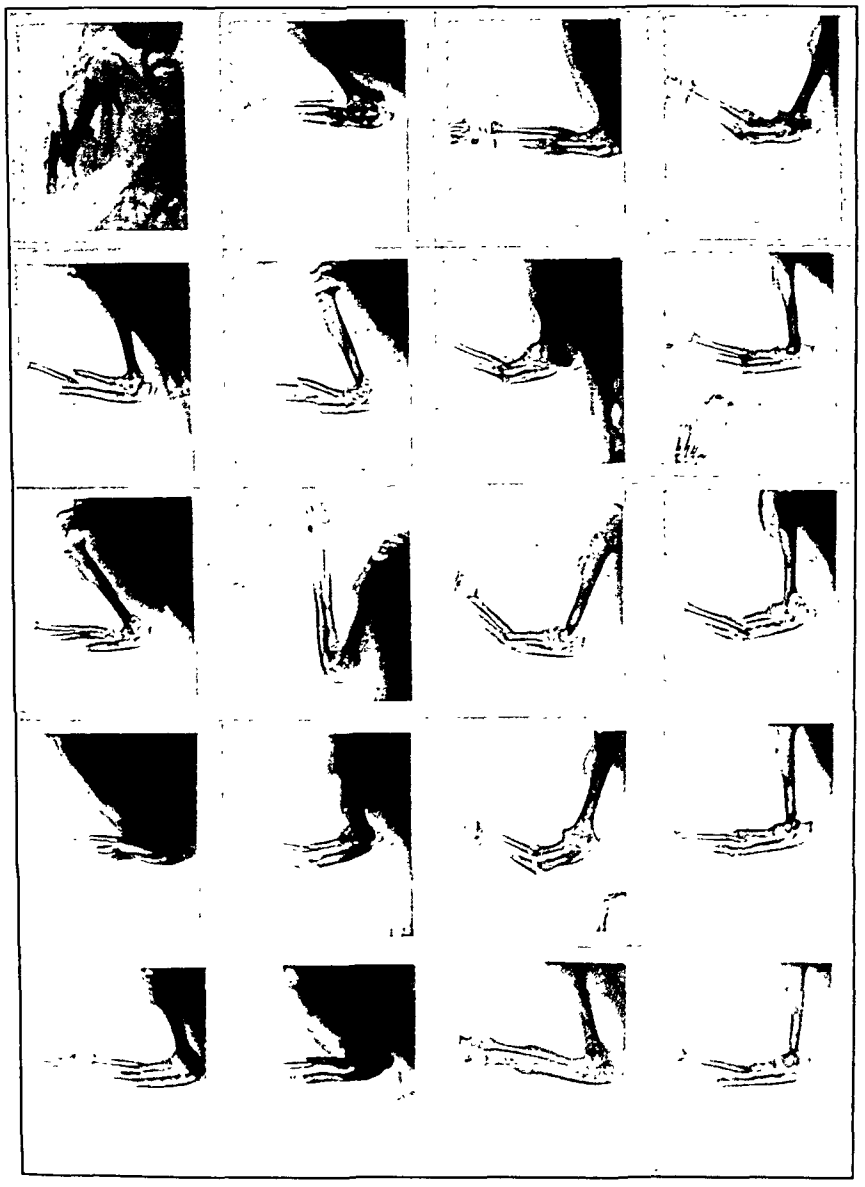


FIG. 1

The two left-hand columns are roentgenograms of the fractures in Group A. For the most part these present the appearance of non-union, although healing had been taking place for three weeks while the animals were on a deficient diet. The two right-hand columns are roentgenograms of similarly treated animals in Group B, except that these animals were allowed to live four more days, during which time they received vitamin D. In this period a well-marked callus appeared in the majority of fractures.

That well-marked typical bone repair had occurred in the fracture areas of the animals of Group A, even though it did not show on x-ray, is illustrated in Figures 3-A and 3-B. Figure 3-A is a section of a fracture in an animal from Group A which showed no evidence of callus on roentgenographic examination. Figure 3-B is a typical section from a healing fracture in Group B.

## DISCUSSION

### *The Reason for Using Two Groups of Animals*

In this experiment we wished to make observations on the blood and fractured bones of animals living for three weeks after the fracture on a deficient diet. We also wished to learn what changes would occur in these animals after the diet was changed. It is literally impossible to obtain these findings and have the animals live afterward, so we could not get both sets of observations from any single animal. Hence we used two groups which, until three weeks after the fracture, were treated identically. At this time the animals in the first group, A, were killed, and the diet was changed in Group B which were kept for four more days. Thus observations on Group A represent the state of affairs in Group B four days before they were killed, and the changes which occurred in that time must have been caused either by the four extra days' healing or the changed diet. As four days was such a small fraction of the total time of the experiment, it seems logical to conclude that the differences in the findings between the animals of Groups A and B were caused by the vitamin D given in the four days at the end of the experiment.

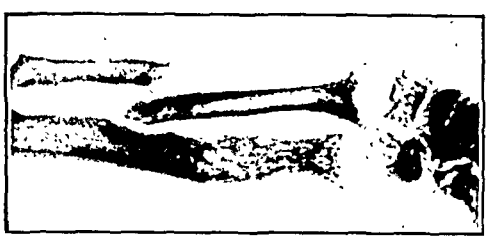


FIG. 2-A

Example of fracture in Group A (enlarged).

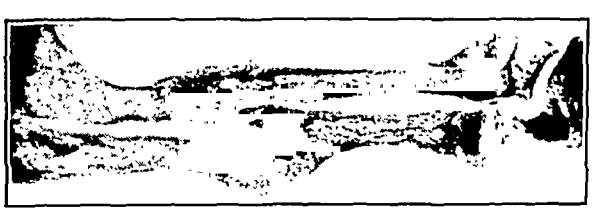


FIG. 2-B

Example of fracture in Group B (enlarged).

### *The Terms "Non-Union" and "Non-Calcification"*

Like so many definitions in present-day use, certain of those used commonly in regard to fractures are decidedly inadequate. For instance, the terms "non-union" and "ununited fracture" are employed to indicate the absence of bony union. Hence "fibrous union" is an example of "non-union". It is a problem to decide whether a fracture which is united by a callus, the organic constituents of which are similar to bone but which are not calcified, should be called "non-union". To settle this question, it becomes necessary to decide whether bone tissue is distinguished from other tissues by its organic constituents or by its

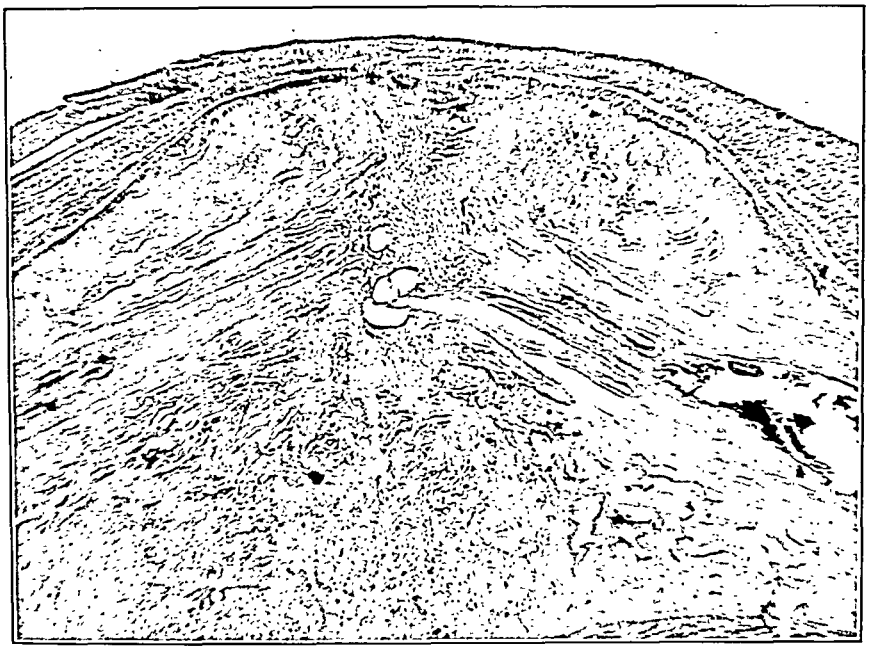


FIG. 3-A



FIG. 3-B

Figure 3-A is a typical example of the histological appearance of a fracture in an animal from Group A; Figure 3-B shows a section of a fracture in an animal from Group B. It is apparent that the administration of vitamin D for four days did not markedly change the histological appearance of the callus tissue, which is abundant in both fractures.

inorganic constituents. In this connection it should be pointed out that other tissues can calcify, taking up exactly the same salts that bone does, but this does not make these tissues into bone. For instance, calcified cartilage is not bone. Consequently, although bone is almost always calcified, and although calcification is its most impressive feature, it is not its distinguishing one. In the last analysis, bone is distinguished from other tissues by the character and arrangement of its organic constituents, and this experiment revealed that these are very similar in uncalcified and calcified bone (callus in Groups A and B). Thus we take the position that the fractures in Group A were examples of true bony union even though the bone was not calcified. Hence "non-calcification" is not "non-union".

*Possible and Not Uncommon Misinterpretations of Action of So-Called "Calcifying Agents"*

The difference between the findings of Groups A and B existed in the x-ray appearances and the blood, and not in the histological sections. However, if the latter had not been studied, it would have been very easy to conclude from the x-ray appearances that vitamin D had caused a remarkable growth of callus in the four days when it was given. Investigation of the histological picture, however, revealed that a good organic callus was in existence before the vitamin D was given and that the vitamin D had no effect on its organic structure. Hence vitamin D does not affect the growth of callus. What it does affect can also be readily misunderstood. If blood findings had not been available in this experiment, it would have been easy to conclude that vitamin D acted as a specific calcifying agent. However, reference to the blood-phosphorus figures reveals that this mineral existed in such small amounts in the blood previous to the vitamin-D administration that calcification could not occur. After vitamin D was given, the blood-phosphorus level rose quickly to a point where normal calcification was able to proceed in the callus which was avid for a calcium-phosphate precipitate. Consequently vitamin D should not be thought of as a specific local calcifying agent, but rather as only one of the many factors concerned in affecting the general calcium and phosphorus metabolism. In this particular experiment it was a marginal factor.

*The Two Aspects of Bone Repair and the Factors Which Control Them*

As this experiment allowed the separation of the two processes—the growth of callus and its calcification—it illustrates that the two processes are controlled by entirely different factors. Consequently, it is easy to see that there is little use in taking therapeutic measures to affect one process (for instance, calcification) when the other process is at fault. As a matter of fact, we know remarkably little about those factors which cause reparative tissue to grow when a bone is broken or even when any other tissue is injured. We are much better informed, however, in

regard to the factors which control the second aspect of bone repair,—namely, calcification. This process is now thought to occur in bone as follows: The fluids surrounding bone matrix are saturated with respect to calcium phosphate, but contain in addition both calcium and phosphorus in other forms, some of those being bound organic compounds. Osteoblasts in the newly forming bone secrete the enzyme phosphatase which splits certain of those bound phosphates, so that additional phosphate ions are liberated in the vicinity. As the solution is already saturated with calcium phosphate, the addition of extra phosphate ions, by mass action, drives down a precipitate of calcium phosphate (the precipitate is more complex, but this is disregarded for the sake of simplicity), and this precipitate is taken up by bone matrix which has a physicochemical affinity for it.

*Possibility of Non-Calcification in Human Cases*

This experiment suggests the possibility that the x-ray picture seen in certain cases, which leads to the diagnosis of meager or tardy callus formation or even non-union, is at least partially accounted for by non-calcification of the callus. At first thought it might be considered that such a possibility could be immediately ruled out by determining the blood calcium and phosphorus level of the patient. Lest too hasty a decision be made upon this matter, it is well to remember that the state of these elements of the blood is just as important as are their amounts, and a great deal remains to be learned about the state of these minerals in the blood. To illustrate this point, an acidosis probably causes a change in the character of the calcium phosphates of the blood, shifting them to the more acid salts which are much more soluble and correspondingly more difficult to precipitate. However, we must await future investigations before we can understand and perhaps remedy various disturbances of the state of the calcium and phosphorus of the blood which would prevent precipitation in bone even though the level of these substances in the blood is normal. In the meantime, although defective bone repair is probably almost always the result of the failure of the first process—the growth of a proper callus—it seems worth while to keep in mind the possibility that the x-ray picture can result from a failure of the second process.

## SUMMARY AND CONCLUSIONS

In this study, fractures were produced in animals which were being fed a diet that deranged their calcium and phosphorus metabolism.

At the end of three weeks, roentgenograms gave the impression that no union had occurred, but histological examination showed the presence of an excellent callus of bony tissue, although it was uncalcified.

Similarly treated animals, allowed to live four days longer and given vitamin D during this period, showed a rapid calcification of the bony callus which was, of course, already in existence. This rapid calcification

excellent, and the fusion solid. Had the eighth thoracic vertebra been included in the fusion in its overcorrected position, this would have necessitated a reversal of the upper thoracic compensatory curve for perfect alignment. The omission from the fusion of one of the vertebrae of the primary curve, which was successful in this case, would not have been safe had the patient been three or more years younger, as growth would be expected to cause an increase of deformity at this site.

*Case 5 (Figures 14, 15, and 16)*

V. P., female, aged seventeen years, had an "idiopathic" right thoracic left lumbar scoliosis, the primary right thoracic curve extending from the fourth to the twelfth thoracic vertebra, with the apex at the eighth (Fig. 14). Marked decompensation and displacement of the trunk to the right and marked prominence of the left hip were noted. The patient had worn plaster casts for two years before coming to this Clinic. A pelvic-tilt examination was not made, as it was not expected that the primary thoracic curvature could be corrected more than enough to restore compensation.

Figure 15, the spine-marker roentgenogram, shows the position of the spine after correction in the jacket immediately before operation. To fuse the minimum area of the primary curve (the fourth to the twelfth thoracic) would probably have given a very satisfactory result. To include one vertebra above and one vertebra below in this instance more nearly approaches the ideal fusion area extending from level vertebra to level vertebra with the transverse axis of each at right angles to the axis of the trunk. Allowing for slight loss of correction during the first year after operation, it was felt that this would not demand more straightening of the compensatory curve below than could be accomplished in this area. Therefore, in 1933, fusion in two stages was done from the third thoracic to the first lumbar.

Figure 16 shows the result three years and ten months later. There is marked improvement in appearance, although by actual measurement the primary curvature is reduced less than 50 per cent. The fusion mass is solid, maintaining nearly all the correction obtained in the jacket. It will be noticed, however, that there is now a slight prominence of the right hip with a slight shift of the trunk to the left, due to the fact that the lumbar compensatory curve below the fusion has not yet straightened enough for perfect alignment. In other words, for this particular case, inclusion of the first lumbar vertebra resulted in somewhat excessive correction at the lower end of the curve. Had a pelvic-tilt examination been made, we should have known how much, or how little, spontaneous straightening to expect in the lumbar curve and would probably have stopped the fusion inferiorly at the twelfth thoracic vertebra.

## COMMENT

At the New York Orthopaedic Dispensary and Hospital, from 1928 to the present time, over 400 patients have had wedging-jacket correction

# PNEUMOROENTGENOGRAPHY OF THE KNEE JOINT *

## An Analysis of Fifty Cases

BY PAUL A. QUAINTANCE, M.D., F.A.C.S., LOS ANGELES, CALIFORNIA

A combination of insufflation with oxygen, carbon dioxide, or atmospheric air, and roentgenography has been used successfully in demonstrating and differentiating injuries to and diseases of the soft-tissue structures of the knee (Kleinberg, Balensweig, Bernstein and Arens, Friedrich, Rechtman, Cattaneo, and Simon, Hamilton, and Farrington). The writer is herewith reporting briefly his experience with pneumoroentgenography as such an aid in diagnosis in fifty patients studied during the last seven years.

### INDICATIONS

Pneumoroentgenography is indicated in cases of long standing, when injury and locking are questionable and, also, when plain roentgenograms disclose no evidence of injury or reveal impacted fracture of the tuberosity of the tibia or avulsion fracture of the condyle of the femur. By this means is made possible differentiation of fractured, loose, or displaced menisci, injury to the cruciate ligaments, fracture of the spines of the tibia, chronic villous synovitis, hypertrophy of the fat pad, and loose bodies in the joint. The method is of value in localizing the seat of pathology and in demonstrating multiple lesions or lesions of soft tissues, symptoms of which are masked by injuries to the bone.

Reports in the literature and the author's own limited experience indicate that the procedure is harmless. However, Kleinberg, in 1927, reported a case of non-fatal pulmonary embolism following an unsuccessful attempt at insufflation of a knee by a hospital resident. No reports of infections attributable to the procedure have come to the writer's attention, and no infections have occurred in this series. One of the author's patients had a fainting spell on the x-ray table, with recovery after a few minutes.

### TECHNIQUE

Under local infiltration anaesthesia, with the knee relaxed in slight flexion on the x-ray table, the joint is insufflated with atmospheric air. Any fluid present is aspirated. A moderate degree of distention of the joint is effected by the injection of from 100 to 150 cubic centimeters of air with an ordinary Luer syringe and needle with a stop-cock.

Stereoscopic anteroposterior and plain lateral roentgenograms are

* An abbreviation of a paper read before the Industrial Medicine and Surgery Section of the California Medical Association at the Sixty-Fifth Annual Session, Coronado, California, May 25 to 28, 1936.

of callus was noted in the roentgenograms. The histological appearance of the fractures changed little in this time.

Non-calcification of a callus is not non-union, because bony union is judged as such by the character and arrangement of the organic constituents of callus and not by its mineral content.

Vitamin D and other so-called calcifying agents do not control the formation or growth of a callus, and only indirectly affect its calcification.

As this experiment clearly separates the two phases of bone repair and illustrates that x-ray appearances of healing can be prevented by a failure of calcification even though a good organic callus is present, it is futile to adopt therapeutic measures directed at one process when the other is at fault, because the two processes are controlled by entirely different factors.

The possibility that certain cases of apparent meager or tardy union or even non-union in human beings are in reality cases of non-calcification should be considered.

TABLE I

ANALYSIS OF TWENTY-FOUR OPERATIONS ON THE KNEE

| Type and Location of Pathology | Pneumoroentgenographic Diagnosis *No. of Cases* | | Operative Findings *No. of Cases* | | Diagnosis Verified *Per Cent.* | Remarks |
|---|---|---|---|---|---|---|
| Fracture of meniscus: | | | | | | Four previously undiagnosed fractures found at operation. In three cases no operation was performed. |
| Medial | 11 | | 12 | | | |
| Lateral | 2 | | 2 | | | |
| | | 13 | | 14 | 71 | |
| Displacement of meniscus: | | | | | | One previously undiagnosed case found at operation. In four cases no operation was performed. |
| Medial | 11 | | 9 | | | |
| Lateral | 4 | | 3 | | | |
| | | 15 | | 12 | 91 | |
| Fracture-displacement of meniscus: | | | | | | |
| Medial | 4 | | 4 | | | |
| Lateral | 1 | | 1 | | | |
| | | 5 | | 5 | 100 | |
| Loose bodies | | 8 | | 3 | 100 | In five cases no operation was performed. In one of the patients operated upon the plain x-ray had failed to show the loose body. |
| Pedunculated bodies | | 0 | | 1 | 0 | |

with a direct blow. Five patients had slipped, ten had fallen, and two had stumbled.

Forty-two patients complained of immediate pain in the knee; twenty-three were unable to extend the leg fully immediately after the accident. Three patients complained of having felt a click or snap, and four had noticed black and blue coloration. Recurrence of symptoms caused twenty-eight, or 56 per cent., of the patients to seek medical attention weeks or months, and in one instance over three years, after the original injury.

Physical examination disclosed tenderness anteromedially in twenty-two patients, anterolaterally in five, medially in four, and laterally in two. Three had tenderness both medially and anteromedially and two had tenderness on the anteromedial and anterolateral surfaces of the knee. In sixteen knees swelling was observed, and from six of them from ten to forty cubic centimeters of fluid was aspirated prior to taking pneumoroent-

made, using a soft-tissue-detail technique. The air is released, the needle is withdrawn, and a sterile dressing and an elastic bandage are applied.

## ANATOMY AND MECHANISM OF INJURY TO MENISCI

The medial meniscus is densely adherent to the capsular and tibial collateral ligaments by fibrous strands and is firmly and closely attached to the rim of the tibia by the fibrous coronary ligaments. Normally the meniscus is only slightly mobile, its anterior horn receding about one-eighth of an inch (three-tenths of a centimeter) posteriorly into the joint when the leg is flexed beyond 20 degrees. The anterior horn has two insertions,—one to the tuberosity of the tibia, the other to the capsule of the joint through the transverse ligament (Cunningham). This dual insertion of the anterior horn, the relative lack of mobility of the medial meniscus, and the wider range of circular, gliding motion of the medial tuberosity of the tibia on the medial condyle of the femur predispose the medial meniscus to disruption and tear when the flexed knee is under stress.

The lateral meniscus, although firmly attached to the capsular ligament, is very loosely adherent by areolar tissue to the fibular collateral ligament. This meniscus is more mobile, and the range of movement of the lateral tuberosity of the tibia on the lateral condyle of the femur is less. Hence, the lateral meniscus is less subject to stress and is infrequently injured.

In the cadaver *, with the coronary ligaments of the knee intact, both menisci are observed to recede fully one-eighth of an inch (three-tenths of a centimeter) posteriorly into the joint during flexion and to resume their normal position and convex contour during extension. When the coronary ligaments are severed anteriorly, recession of the menisci during flexion increases to as much as three-eighths of an inch (one centimeter). On extension, the menisci fail to resume their normal position and contour and are impinged between the femoral condyles and the tibial tuberosities. Full extension of the leg is not possible. Rupture of the coronary ligaments, therefore, predisposes to displacement, impingement, and bruising of the menisci and limitation of extension or locking of the knee.

## ANALYSIS OF CASES

Clinical and pneumoroentgenographic studies were made on fifty patients,—forty-seven males and three females. The right knee was involved in thirty-two cases; the left, in eighteen.

A history of a twist was given by thirty-two patients, twenty-four of whom stated that the knee was flexed when the accident occurred. Thirteen had a direct blow about the knee. Seven reported that the knee had been forced medially or laterally; in four cases this had been in association

* Dissections done through the courtesy of Dr. Paul McKibben, Professor of Anatomy, University of Southern California Medical School.

displacement was found in a knee in which fracture of a meniscus had been diagnosed. The percentage of correct diagnoses of displacement of the meniscus, as verified by arthrotomy, was 91.

In five patients in whom both fracture and displacement of a meniscus were diagnosed by pneumoroentgenography, the diagnosis was proved by arthrotomy, making the percentage of correct diagnoses of fracture-displacement of the meniscus 100.

Of the eight patients in whom loose bodies were diagnosed by pneumoroentgenography, three submitted to operation and the diagnosis was proved. In one of these patients plain x-rays prior to pneumoroentgenography had failed to demonstrate a loose body.

A pedunculated body, which the pneumoroentgenogram had failed to demonstrate, was found at operation in another patient.

Baker's cysts (single, unilocular, multilocular, and multiple) were demonstrated in four patients.

Hypertrophic arthritic changes were present in the x-rays of eight patients.

Fractures of the distal end of the femur were observed in two patients and fractures of the proximal end of the tibia in five.

In six patients no pathology in either bony or soft tissues was demonstrated.



FIG. 2-A

Case 17. G. G., March 4, 1932. Note absence of the shadow of the lateral meniscus from its usual position. Note also that the lateral and medial joint spaces are of equal width.



FIG. 2-B

Case 17. G. G., March 4, 1932. Note abrupt break in continuity and upward displacement of the lateral meniscus, fracture defect in the lateral condyle, and narrowing of the lateral tibiofemoral joint space.



FIG. 1-A

Case 9. A. G. H., July 1, 1931. The shadow of the medial meniscus (anteroposterior view) is normal in position and appearance.



FIG. 1-B

Case 9. A. G. H., July 1, 1931. The hypertrophied retropatellar fat pad (lateral view) projects into the intercondylar notch even when the joint is distended. It also is seen quite clearly in Fig. 1-A.

genograms. There was limitation of extension in twenty-four patients and of flexion in eighteen. Instability at the knee was found in six cases, resulting from fracture of the lateral tuberosity of the tibia in two cases, avulsion fracture of the condyle of the femur in two, and injury to the cruciate ligaments in two. There were findings indicating sprain of the tibial collateral ligament in eleven patients and of the fibular collateral ligament in two.

In two patients solitary loose bodies were palpated about the knee.

### PNEUMOROENTGENOGRAPHIC AND OPERATIVE FINDINGS

Of the fifty knees of which pneumoroentgenograms were taken, twenty-four, or 48 per cent., were subjected to arthrotomy. As shown in Table I, fracture of a meniscus (medial in eleven, lateral in two) was diagnosed in thirteen patients, only ten of whom came to operation. Diagnosis of a fractured meniscus was confirmed in all ten. Fracture of a meniscus was found in four additional knees in which it had not been demonstrated by the pneumoroentgenograms. In one of these, however, displacement had been diagnosed. Therefore, the percentage of correct diagnoses of fracture of the meniscus proved by arthrotomy was 71. In three unoperated patients the diagnosis was not confirmed.

Displacement of a meniscus (medial in eleven, lateral in four) was diagnosed by pneumoroentgenography in fifteen patients, in eleven of whom the diagnosis was confirmed by arthrotomy. In an additional patient

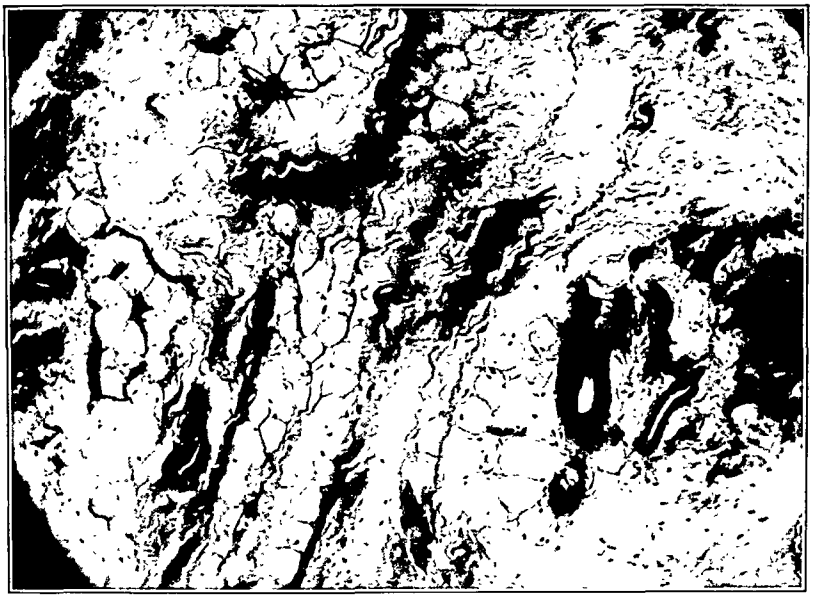


FIG. 3-B

Case 17. Photomicrograph of area of degenerative and regenerative changes in injured cartilage.

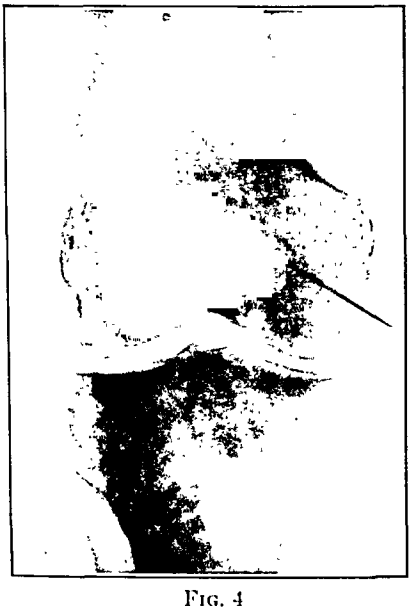


FIG. 4

Case 24. L. D., June 17, 1932. The displacement and elevation of the anteromedial portion of the medial meniscus from the articular margin of the tibia is shown by the air space between them. Note the normal juxtaposition of the lateral meniscus and the lateral tuberosity of the tibia.



FIG. 5

Case 28. B. E., September 28, 1932. The air space distal to the lateral meniscus indicates rupture of the coronary ligaments, allowing displacement; the mottling denotes fatty degeneration of cartilage. A portion of the longitudinal fracture of the meniscus found on arthrotomy can be seen as a transverse line near the anterior horn.



FIG. 3-A

Case 17. Gross longitudinal section of injured lateral meniscus, showing site of fracture, areas of degeneration, vascularization, and replacement by fibrous tissue.

REPORTS OF ILLUSTRATIVE CASES

CASE 9. A. G. H., male, twenty-eight years old, a bookkeeper, on May 13, 1931, experienced pain on the anteromedial surface of the right knee in squatting after a broad jump. For two months he frequently felt something "go out of place and snap in after a few movements", during which intervals extension was limited.

Examination revealed tenderness anteromedially and slightly limited extension.

Pneumoroentgenograms (Figs. 1-A and 1-B), taken on July 1, 1931, after the aspiration of ten cubic centimeters of thick, amber, clear fluid, showed a large, dense triangular shadow in the anterior intercondylar notch, which was interpreted as a hypertrophied fat pad. Although the history and physical findings were typical of disruption of the medial meniscus, such injury could not be demonstrated. Arthrotomy was not done. Three months later the patient was reported to be "getting along well".

*Diagnosis:* Hypertrophy of the retropatellar fat pad.

CASE 17. G. G., male, forty-five years old, a timberman, on April 28, 1931, was buried when a trench caved in. Pain, wobbling, recurrent locking, limited flexion in the left knee, and disability were complained of for eight months.

Examination revealed tenderness laterally, slight lateral instability, restriction of flexion, and atrophy of the thigh muscles. Climbing stairs caused increased pain, swelling, and recurrence of locking. Plain x-rays had revealed a small ununited avulsion fracture of the lateral condyle, to which the symptoms had been attributed.

Pneumoroentgenograms (Figs. 2-A and 2-B), taken on March 4, 1932, disclosed a fracture of the lateral meniscus and an oblique shadow of cartilaginous density in the lateral compartment of the joint. The lateral joint space was narrow and the cartilage shadow was absent from its usual position. A diagnosis of fracture-dislocation of the *lateral* meniscus was made. Two orthopaedic surgeons diagnosed injury to the *medial* meniscus.

Medial meniscectomy, on March 31, 1932, revealed insufficient pathology to explain the symptoms. A second incision laterally disclosed a transverse rent in the joint capsule, and fracture, and upward lateral displacement of the anterior horn of the lateral meniscus. Lateral meniscectomy also was done.

Longitudinal section (Fig. 3-A) through the region of the fracture showed clearly the abrupt fragmentation and partial degeneration and regeneration of the anterior horn. The microscopic picture of the fatty degeneration, vascularization, and proliferation of connective tissue which followed the injury is shown in Figure 3-B.

*Diagnosis:* Fracture-dislocation of the lateral meniscus.

CASE 24. L. D., male, thirty-six years old, a wire worker, while stepping up on an iron horse on April 22, 1932, experienced snapping, pain, and locking of the right knee. Manipulation under anaesthesia gave no relief.

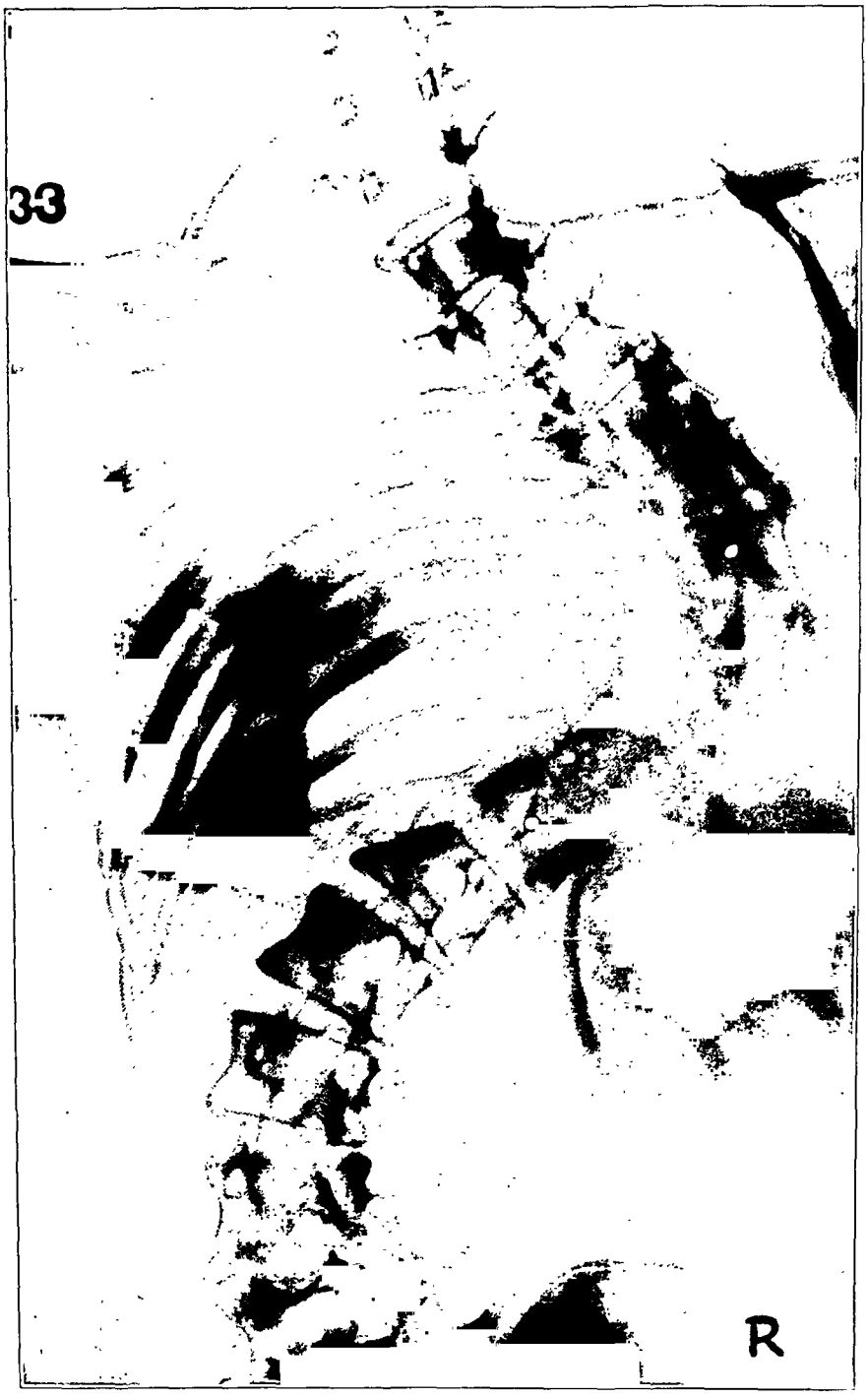



FIG. 14

Case 5. Preoperative roentgenogram, with patient standing.

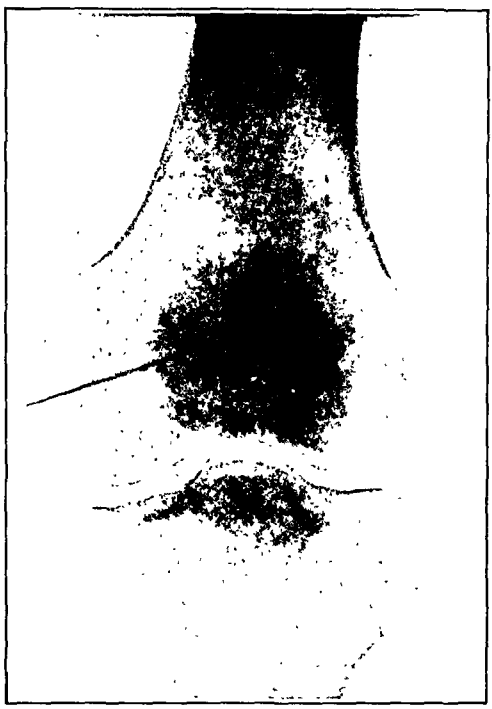


FIG. 6-A

Case 30. L. S., November 22, 1932. Fracture defect in the lateral tuberosity and narrowing of the lateral tibiofemoral joint space are seen in this pneumoroentgenogram taken with the limb relaxed.



FIG. 6-B

Case 30. L. S., November 22, 1932. Note absence of the shadow of the lateral meniscus from the joint space. Arthrotomy revealed it in position of the shadow adjacent to the lateral condyle of the femur.

Examination revealed slight fluctuant swelling and moderate restriction in flexion and extension. The cartilage spring test was positive on the medial side.

The first pneumoroentgenograms, taken on April 22, 1932, after aspiration of twenty cubic centimeters of bloody fluid, were not diagnostic, although the medial meniscus was mottled near the collateral ligament. A follow-up pneumoroentgenogram (Fig. 4), taken on June 17, 1932, showed elevation of the anterior portion and an oblique fracture of the medial meniscus at the junction of its middle and anterior portions.

Arthrotomy on July 22, 1932, disclosed a bucket-handle fracture, contusion, and upward displacement of the middle portion of the medial meniscus.

*Diagnosis:* Bucket-handle fracture and displacement of the medial meniscus.

CASE 28. B. E., male, twenty-seven years old, an iron worker, twisted his right knee on August 8, 1932, while squatting, and had recurring pain and locking for six weeks. This knee had been sprained three and two years previously.

Examination revealed tenderness anterolaterally and posteriorly to the head of the fibula, slight limitation of flexion and extension, and a positive cartilage spring test.

A pneumoroentgenogram (Fig. 5), taken on September 28, 1932, showed thinning, mottling, and upward displacement of the lateral meniscus.

Arthrotomy on October 7, 1932, disclosed a longitudinal fracture, detachment, and upward displacement of the anterior horn, the tip of which remained attached.

*Diagnosis:* Fracture-displacement of the anterior horn of the lateral meniscus.

CASE 30. L. S., male, thirty-seven years old, a salesman, on June 7, 1932, doubled his left knee under him in falling off a truck. For five and one-half months there was persistent pain laterally with a tendency to "give way".

Examination revealed tenderness and crepitus anterolaterally and slight anteroposterior instability.

Serial pneumoroentgenograms (Figs. 6-A and 6-B), taken on November 22, 1932, showed the lateral *attachment* of the lateral meniscus to be displaced upward five-eighths of an inch and a healed impacted fracture of the lateral tuberosity of the tibia. The second pneumoroentgenogram, with pressure exerted laterally, showed widening of the lateral joint space and upward displacement of the meniscus.

Arthrotomy on November 29, 1932, disclosed detachment and displacement of the entire lateral meniscus with the exception of the insertion of its anterior horn.

*Diagnosis:* Displacement of the lateral meniscus complicating fracture of the tuberosity of the tibia.

## SUMMARY

In this study pneumoroentgenography, using atmospheric air, was done on fifty knee joints.

Hypertrophy of the retropatellar fat pad, indicative of chronic synovitis or injury, was demonstrated in twenty-one knees. The pad was palpably enlarged in only seven patients.

Baker's cysts were demonstrated in four knees.

Fracture of the meniscus was diagnosed by pneumoroentgenography in 71 per cent. of the knees in which fractured menisci were found at operation. Three knees remained unoperated.

Displacement of a meniscus was diagnosed in 91 per cent. of the knees in which a displaced cartilage was found on arthrotomy.

Fracture-displacement of a meniscus was verified by arthrotomy in 100 per cent. of the knees in which this diagnosis was made.

Loose bodies were diagnosed in eight knees and removed from the three knees operated upon. One undemonstrated pedunculated body was found at operation.

Thirty-two knees had suffered a twist; in twenty-four, or 75 per cent., the accident had occurred while the knee was flexed. In twenty-four, or 48 per cent. of the fifty cases, there had been limitation of extension.

## CONCLUSIONS

Pneumoroentgenography is a simple, harmless, practicable, and valuable aid in the differential diagnosis of injuries and diseases of the soft-tissue structures of the knee.

Its efficiency in demonstrating fracture and displacement of the menisci, as verified by arthrotomy, was 87 per cent. in this series.

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# POSTERIOR HERNIA OF THE KNEE JOINT

## A Cause of Internal Derangement of the Knee *

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The object of this paper is to direct attention to the occurrence of synovial cysts in the popliteal space, and in particular to one type of cyst which at operation is found to be a posterior hernia of the knee joint. In the presence of such pathology the patient's symptoms suggest an internal derangement of the knee. Hence, with patients who complain of knee-joint disability, it is always important to examine the popliteal space for the presence of a swelling. This examination is most informative if the patient bears weight on the extremity and if the knee is held in a position of complete extension. If a cystic swelling is noted, the greater part of which is distal to the transverse skin crease in this region (Fig. 1), then posterior hernia of the joint may be the cause of the symptoms.

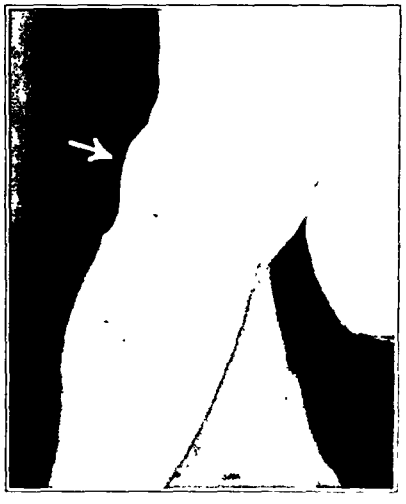


FIG. 1

Case 1. A localized, well-developed cystic swelling of the popliteal space.

In reviewing the literature, the first accurate description of an abnormal synovial swelling in the popliteal space was found in a short clinical report, "Chronic Rheumatic Arthritis of the Knee Joint", by Adams in 1840. Todd also attributed this "dropsical condition of the popliteal bursa" to chronic rheumatic arthritis.

In the papers published by Gruber, beginning in 1845, a complete study of these cases was presented. The anatomy of enlarged bursa in the popliteal space, as well as true posterior hernia of the knee joint, was described. Billroth, in his textbook, "General Surgical Pathology", accepted Gruber's conclusions.

More than thirty years after publication of the articles by Adams and Gruber, Baker, of St. Bartholomew's Hospital, London, discussed the formation of synovial cysts in the leg in relation to disease of the knee joint. This author believed that the cysts were caused by osteo-arthritis of the knee, an opinion based on the findings at dissection of amputated extremities. In two communications, Baker reported his observations on ten patients with cystic swelling about the knee. In three cases, the examination after amputation indicated there was a true posterior hernia

* Read before the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

of the joint. In the remaining cases either infection did not occur, and hence pathological examination was not possible, or the cyst was apparently an enlargement of one of the joint bursae. As a result of these case reports, any cystic swelling about the knee with a cellular lining similar to that of synovial membrane is often referred to in the English literature as a Baker's cyst.

Posterior hernia of the knee joint or hyperplasia of an adjacent bursa is the cause of a synovial cyst in the popliteal space. From the clinical standpoint, the essential difference between the two conditions is that, although an enlarged bursa may communicate with the joint, a posterior hernia always exhibits this relationship and is the cause of symptoms characteristic of an internal derangement of the knee. This clinical syndrome is not now widely recognized and hence the present series of cases is reported.

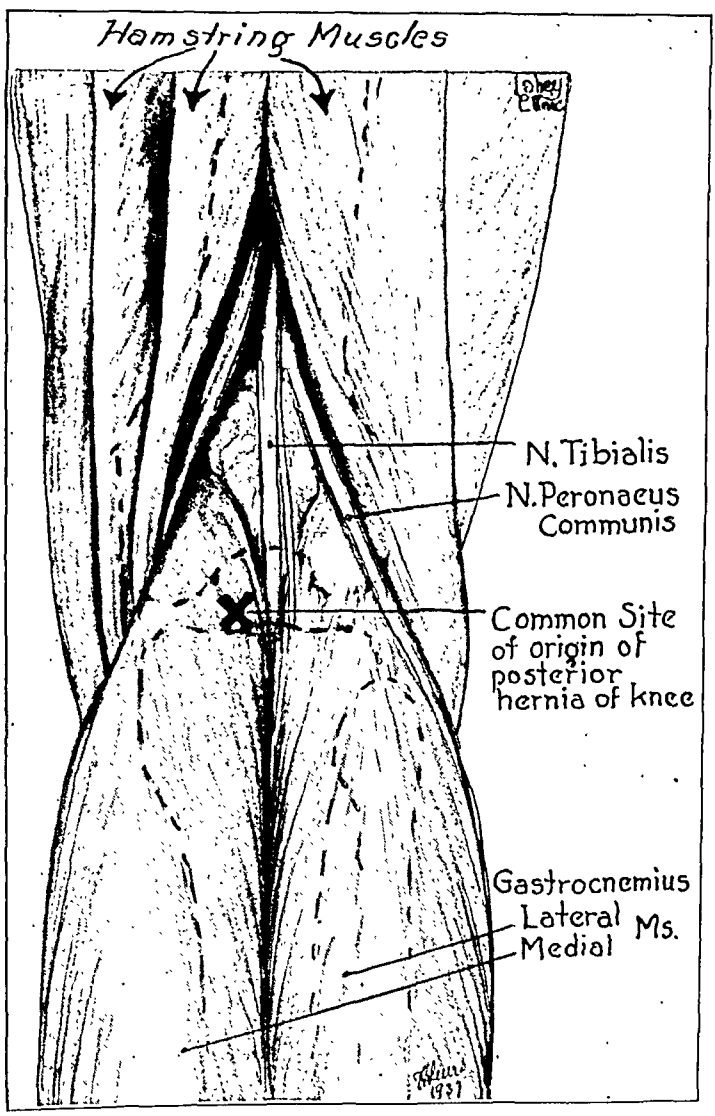



FIG. 2

Normal anatomy of the popliteal space. Posterior hernia of the knee joint usually arises below the oblique popliteal ligament of the joint capsule and just medial to the mid-line, as indicated.

In consideration of the anatomy of the popliteal space (Fig. 2) and the distance of the joint capsule from the skin surface, it is reasonable to assume that in the early stages herniation would not cause undue symptoms, nor would it be possible to detect clinically. That is particularly true because of the subcutaneous fat pad which overlies this space and from which, incidentally, it is often difficult to differentiate a true posterior hernia of the joint. Gradually increasing in size, the sac dissects its way through the soft fatty tissue of the popliteal space, in the line of least resistance, and finally lies between the two heads of the gastrocnemius muscle. With further in-

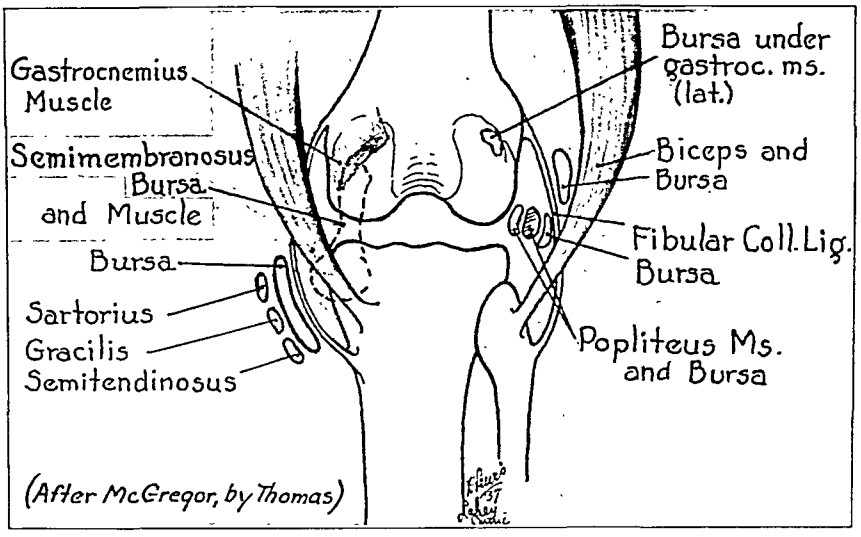



FIG. 3-A

Diagrammatic drawing showing location of bursae about the posterior knee region.

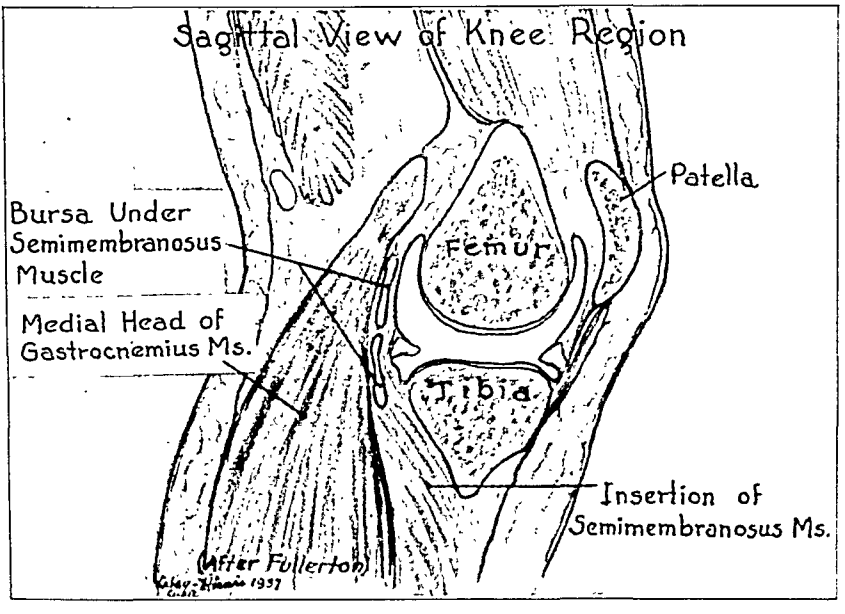



FIG. 3-B

Diagrammatic drawing illustrating the anatomical relationship of the semimembranosus bursa which most frequently communicates with the knee joint.

crease in size, the sac then extends down the leg under the deep fascia, as a rule more on the mesial than on the lateral aspect of the calf. In three patients the distal end of the sac reached the mid-calf region.

Of the twelve bursae around the knee joint, two are posterior (Fig. 3-A) and are found between each head of origin of the gastrocnemius muscle



FIG. 4-A

Case 2. Photomicrograph (× 48) showing part of the wall of the hernial sac with pseudocystic outpocketing from that wall. Note the marked vascularity and round-cell infiltration of the subserous layer. *(Courtesy of Dr. Shields Warren.)*



FIG. 4-B

CASE 2. Photomicrograph (× 200) showing lining of the pseudocyst and outpocketing. Note particularly that the fibrous-tissue wall is lined with typical synovial cells. (*Courtesy of Dr. Shields Warren.*)

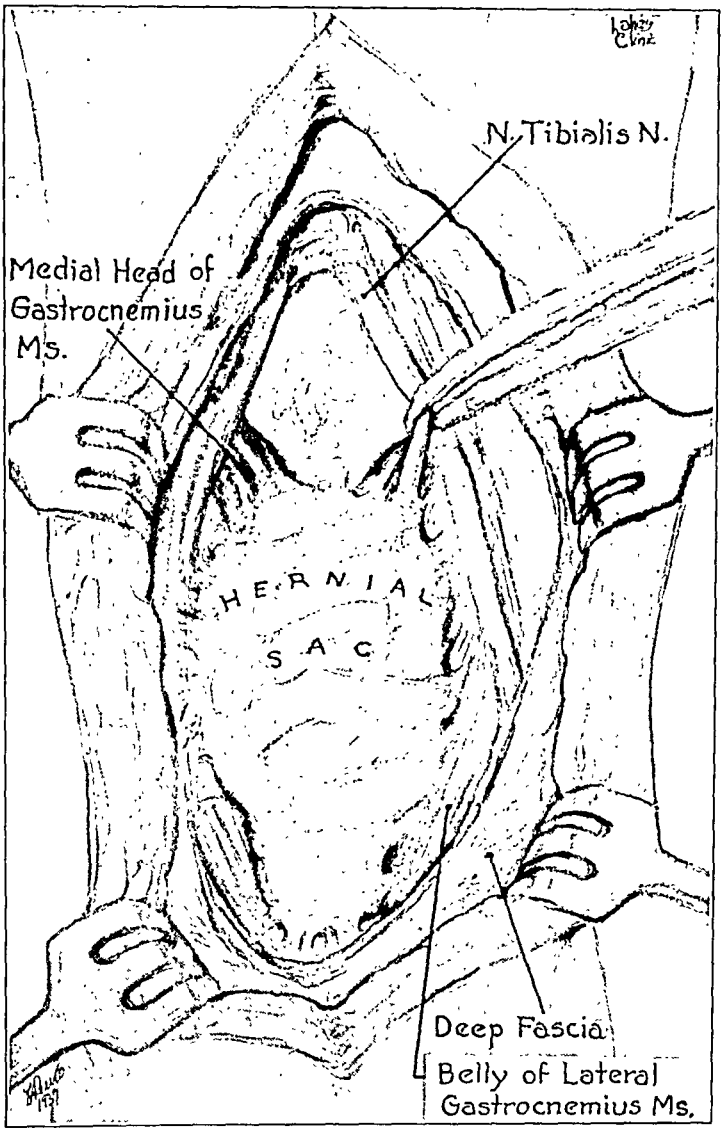



FIG. 5

Exposure of the hernial sac following division of the deep fascia and preliminary dissection. Note the adhesions to the gastrocnemius.

and the joint capsule. They may communicate with the knee joint, particularly that bursa beneath the inner head of the gastrocnemius which sends a prolongation between this muscle and the semimembranosus, and which is termed the semimembranosus bursa (Fig. 3-B). One patient was operated on for enlargement of this bursa, but the swelling was definitely located at the inner side of the popliteal space, and the dissection at operation clearly revealed the point of origin from beneath the medial head of the gastrocnemius muscle. A definite communication with the joint was not demonstrated in this case.

In eight patients the hernial sac communicated with the knee joint by a short pedicle which averaged one centimeter in length, with walls of quite dense connective tissue. The opening in the posterior capsule was usually below the oblique popliteal ligament and slightly medial to the mid-line. The distal wall of the larger sacs was quite thin and firmly adherent to the tendon fibers of the gastrocnemius muscle.

On histological examination, the lining of the hernial sac and of the enlarged bursa was found to be a true mesothelium (Figs. 4-A and 4-B), in every way similar to the lining of the knee joint. In all of the specimens removed there was acute and chronic inflammation of the serous lining, together with a moderate to marked round-cell infiltration in the subserous layers. The outer wall of the sac, adjacent to the site of origin, was composed of relatively dense fibrous tissue similar to the capsule of the knee joint, while the more distal portion was a fine connective tissue

quite friable and easily ruptured.

The most difficult differential diagnosis in these cases is to distinguish between a true posterior herniation of the joint or hyperplastic bursitis and a lipoma in the popliteal space or the usual fat pad that is present. The majority of true herniae in this region vary somewhat in size and likewise give rise to a varying degree of subjective symptoms. Furthermore, the popliteal swelling due to posterior joint hernia is in greater part distal to the transverse skin crease of this region. In obese patients, the deposit of fat in the popliteal space may be quite pronounced and not only has the appearance of a cystic swelling, but on palpation suggests it. In two patients such a fat pad was found at operation and in one instance proved to be a definite lipoma. Incidentally, it is of interest to note that following the removal of this fat tissue the swelling of the lower leg and foot, which was previously present, entirely disappeared.

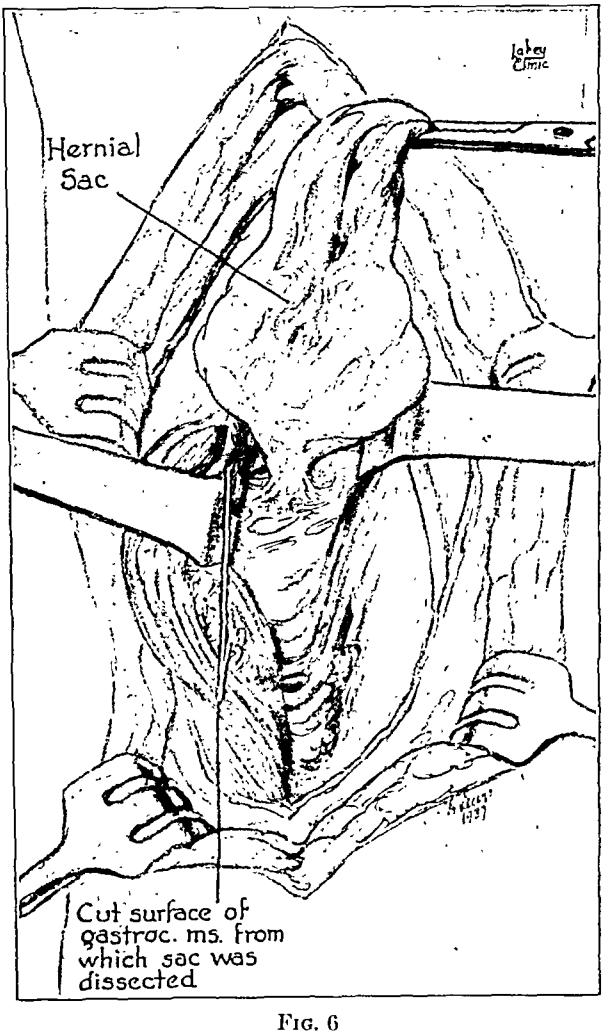



FIG. 6

*The sac has been dissected free except for the pedicle which communicates with the knee joint. Note the cut surface of the gastrocnemius from which the sac was cut.*

One patient with what proved to be a fibrosarcoma of the popliteal space was originally considered as a possible member of this group of cases, but, on palpation, the swelling was definitely hard and tender, in contrast to the cystic character and relatively painless tumor of the hernial sac. Aneurysm of the popliteal artery, so frequently noted in earlier reports, is not now often encountered.

At operation, a mid-line incision is made over the popliteal space and the site of the swelling. The lower end of the incision is directed toward

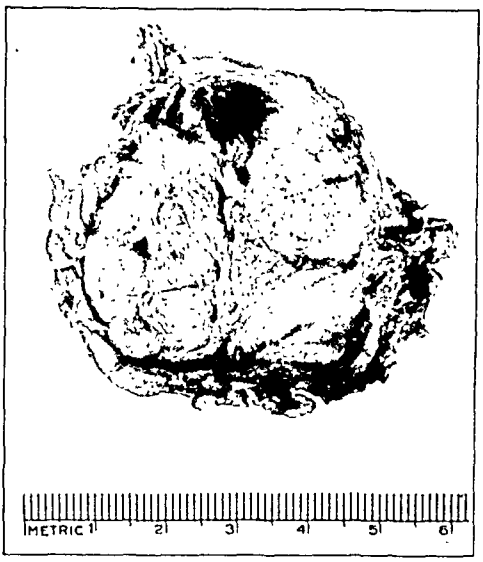



FIG. 7
Hernial sac removed in Case 9.

the medial or lateral side, depending on the location of the sac. Following division of the deep fascia, blunt dissection reveals the fibroserous wall of the sac (Fig. 5) which is then freed by sharp dissection, beginning at the more distal portion. It is always necessary to excise a part of the tendinous fibers of the gastrocnemius muscle (Fig. 6), because the wall of the hernial sac is so adherent that attempting to dissect it free results in rupture of the wall.

The popliteal nerve and, in the deep dissections of this space, the popliteal vessels are displaced to the lateral side of the leg to permit delivery of the sac, identification of its pedicle, and the point of communication with the joint space (Figs. 5 and 6). Once the sac is entirely free (Fig. 7), the pedicle is clamped and cut. The stump is then inverted into the joint space, and the foramen in the capsule is closed with heavy silk mattress sutures (Fig. 8). Tight closure of the foramen in the knee-joint capsule is an important step in preventing recurrence of the hernia.*

The wound is sutured in layers, special care being taken to approximate the edges of the deep fascia. A posterior plaster splint (Fig. 9) is then applied from the gluteal fold to the ankle, with the knee joint in full extension. This splint is worn for ten days to prevent scar formation, due to healing of the wound, from occurring with the knee in the flexed position. During this interval, the patient actively contracts the quadriceps muscle repeatedly.

During the immediately postoperative period, the knee is distended with fluid, sometimes to a marked extent, a reaction similar to that which occurs following removal of a meniscus. This fluid is gradually absorbed, or, if it persists, can be aspirated. It is believed that this degree of reaction is chiefly the result of a disturbance of the dynamics of the fluid in the knee joint.

After the splint is discarded, more active muscle exercise is instituted, again with particular attention to the function of the quadriceps muscle. Early weight-bearing with crutches is encouraged.

During the past four years twelve patients have submitted to operation for cystic swelling of the popliteal space. In nine knees a posterior hernia of the joint was demonstrated. In one case the cystic swelling was caused by enlargement of the semimembranosus bursa. In another case the swelling was a lipoma, and in the remaining patient there was a diffuse

* Geoffrey Jefferson observed recurrence of the cystic swelling in a child, six years old, whom he saw two months after operation elsewhere.

swelling over the popliteal region, due to hyperplasia of the subcutaneous fat pad. The average duration of symptoms in this group of patients was four years: the longest period was ten years; the shortest, six months. Eight of the patients were female and four were male. The youngest was a girl of ten; the oldest, a man of sixty-two years. Bilateral posterior hernia or enlarged bursa of the knee joint was not observed.

All of the patients in this group sought relief for generalized aching, and at times severe, sharp, "binding" pains in the knee joint, occasionally associated with intermittent effusion into the joint cavity. Ten patients described recurrent swelling of the lower leg and foot. In the course of observation in three cases it was found that, when the effusion into the knee joint was marked, the swelling in the

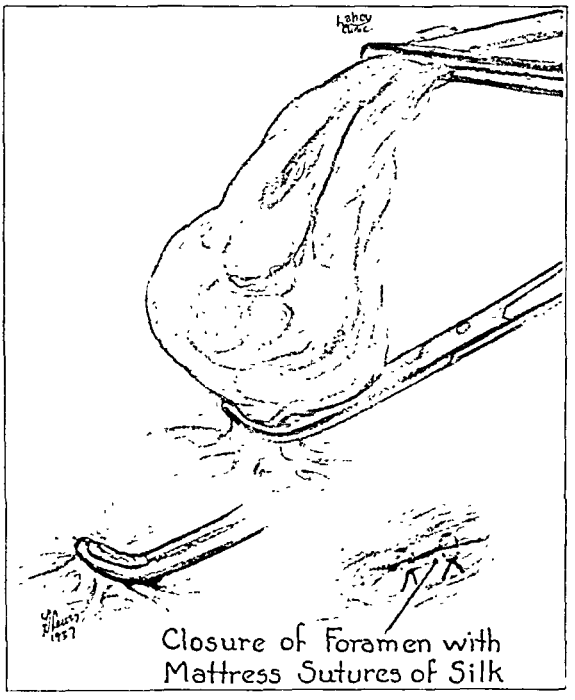



FIG. 8

The pedicle of the hernial sac is clamped and cut. With sufficient tissue in the stump, it is then inverted into the joint space, and the foramen in the capsule is closed with silk mattress sutures.

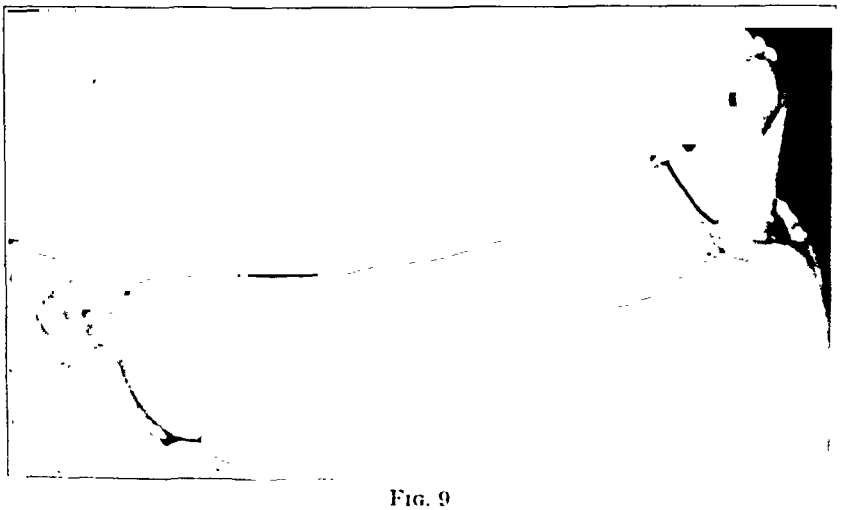


FIG. 9

After the operative wound is dressed, a posterior plaster splint, extending from the gluteal fold to the ankle, is applied with the knee joint in full extension.




FIG. 15

Case 5. Preoperative spine-marker roentgenogram, with patient in wedging jacket.

may be suspected when a cystic swelling is found in the popliteal space, particularly if located in the mid-line and, in greater part, distal to the skin-flexion crease in this region.

Clinically, the chief symptoms vary from aching discomfort to severe, binding pain in the knee region, often associated with intermittent effusion into the knee joint. There is a moderate to marked degree of disability.

The hernial sac communicates with the knee joint usually by a pedicle, one to two centimeters in length, arising either above or below the oblique popliteal ligament. The sac may occasionally dissect its way distally to the mid-calf region, lying on top of the gastrocnemius muscle and beneath the deep fascia.

On histological examination, the lining of the hernial sac is found to be a true mesothelium which cannot be distinguished from the synovial membrane of the knee joint. There is acute and chronic inflammation of the serosa, as well as round-cell infiltration of the subserous layers.

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popliteal space became much less pronounced. In one instance the popliteal swelling entirely disappeared, apparently the result of a sudden discharge of the contents of the hernial sac into the knee-joint cavity. One other patient said that when he had first noted something the matter with his knee it apparently contained fluid. At a somewhat later date this suddenly disappeared and the swelling in the popliteal space then appeared. In three instances the fluid in the knee joint remained for a period of time and was eventually absorbed, and then the cycle was repeated.

The frequency with which this interchange of synovial fluid between the hernial sac and the knee joint occurs apparently depends on the particular mechanics of the opening communicating between the two regions,—that is, if the pedicle of the hernial sac becomes twisted or crushed upon itself, or unduly thickened so that the lumen is blocked, then the popliteal swelling is consistently present. If the lumen of the pedicle is patent, fluid moves from one space into the other, depending on the activities of the individual, and especially appears to be affected by long periods of standing with the knee joint fully extended. This latter position tends to compress the hernial sac and to force the contained fluid into the knee joint. In every case in which operation was performed, however, the foramen between the joint cavity and the hernial sac was patent, although in some instances there was marked fibrosis of the pedicle of the sac with a narrow lumen. Four patients had never noticed fluid in the knee joint proper. On the other hand, with two exceptions, none of the group had observed a swelling in the popliteal space.

The roentgenograms of these knee joints consistently did not reveal any abnormality except in the older patients in whom some slight degenerative changes were found. The latter probably had in some measure been increased because of the irritative reaction set up by the interchange of fluid between the hernial sac and the joint, but in no instance were these changes marked.

Seven patients obtained relatively rapid increase of motion in the knee, so that within three weeks after operation normal flexion and extension without swelling of the joint were present, as well as adequate function of the muscles of the lower extremity. In two instances the interval was longer,—one patient required four weeks and the other six weeks to obtain full motion. This delay was due to the long duration of symptoms and to the seriously compromised function of the quadriceps muscle before operation, together with the fact that neither of these two individuals was very robust or active.

The longest follow-up in this series is four years; the shortest, eight months. In each of the patients the extremity is now normal and measures the same as the non-operated leg. None of the patients has experienced any further symptoms in the knee joint.

## SUMMARY

In the presence of posterior hernia of the knee joint the patient's symptoms suggest an internal derangement of the knee. This condition

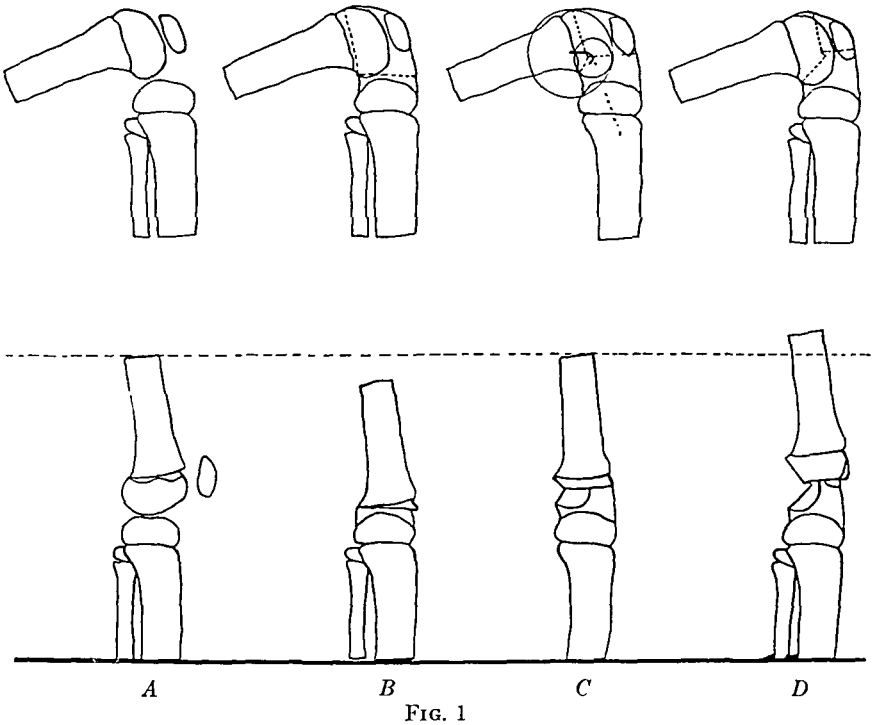



FIG. 1

*A:* Outline of the roentgenograms of a child's knee in flexion and in extension.

*B:* Outline of a regular wedge osteotomy showing the shortening that occurs in correction.

*C:* Outline of an osteotomy with the pivot at the approximate center of motion of the knee, showing that in the corrected position the original length is maintained. The upper diagram also shows that the posteriorly slanted section of the tibia is a function of a small radius of hinged knee-joint motion.

*D:* Outline of an anterior wedge osteotomy showing that the length of the corrected leg is longer than the original extremity.

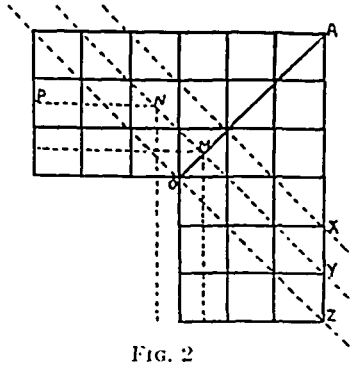



FIG. 2

A diagram visualizing the effect of the location of the pivot of an osteotomy in relation to the length of the corrected extremity.

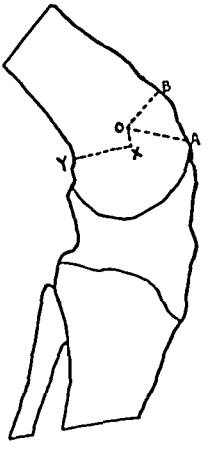



FIG. 3

Outline of a flange osteotomy.

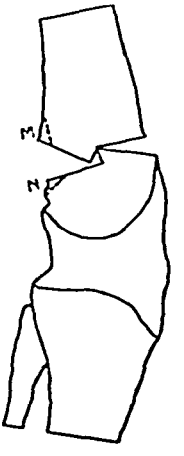



FIG. 4

Flange osteotomy with the fragments in partial correction.

# FLANGE OSTEOTOMY FOR THE CORRECTION OF KNEES ANKYLOSED IN FLEXION

BY HENRY BRIGGS, M.D., NEWARK, NEW JERSEY

*From the New Jersey Orthopaedic Hospital and Dispensary*

By osteotomy and a wedging turnbuckle plaster encasement, a knee ankylosed in flexion can be straightened without injury to the circulation or to the innervation of the distal fragment. The truth of this proposition has been demonstrated by Whitman. It is the author's purpose to show that, by the location of the pivot of motion, such an extremity may be shortened, or its original length may be maintained or increased by osteotomy, and to present a new technique of correction by flange osteotomy.

In order to show the effect of the location of the pivot on the length of the straightened extremity, tracings of lateral roentgenograms of a normal child's knee in right-angled flexion and in extension have been made. By using the tracing of the knee in right-angled flexion as a model, various corrections have been made and the resulting length has been compared with that of the knee in extension.

Figure 1 demonstrates that the ordinary wedge osteotomy shortens the extremity in comparison with its original length, that a wedge osteotomy with a pivot at the approximate center of motion of a knee maintains the original length, and that an anterior wedge osteotomy may lengthen the extremity.

The mechanism of these relationships can be visualized by a study of Figure 2. It is obvious by counting the squares that a pivot located at *O* on the line *OA* gives the greatest shortening, and that the further toward *A* on the line *OA* the pivot is moved, the longer becomes the straightened extremity. Furthermore, an extremity straightened with a pivot on one point on the line *X* will be equal in length to an extremity straightened with a pivot on any other point on the line *X*. The same can be said for lines *Y* and *Z*. Thus, a supracondylar osteotomy could be performed at *N* with the same effect in length as if it were performed at *M*. In other words, a study of this diagram shows that the length of the straightened extremity will be equal to the long axis of the proximal fragment plus the long axis of the distal fragment, both axes being projected from the actual pivotal point of the osteotomy.

A flange osteotomy is simply an anterior wedge osteotomy constructed with a flange to aid in preventing posterior displacement of the distal fragment in the process of gradual extension. Figure 3 shows the construction of an anterior wedge *AOB* with *O* as the pivot and a line *OA* perpendicular to the long axis of the tibia and the line *OB* perpendicular, or slightly less than perpendicular, to the long axis of the femur, depending on whether the desire is to have the corrected extremity straight or



FIG. 7

B. E. End result approximately two years after operation.

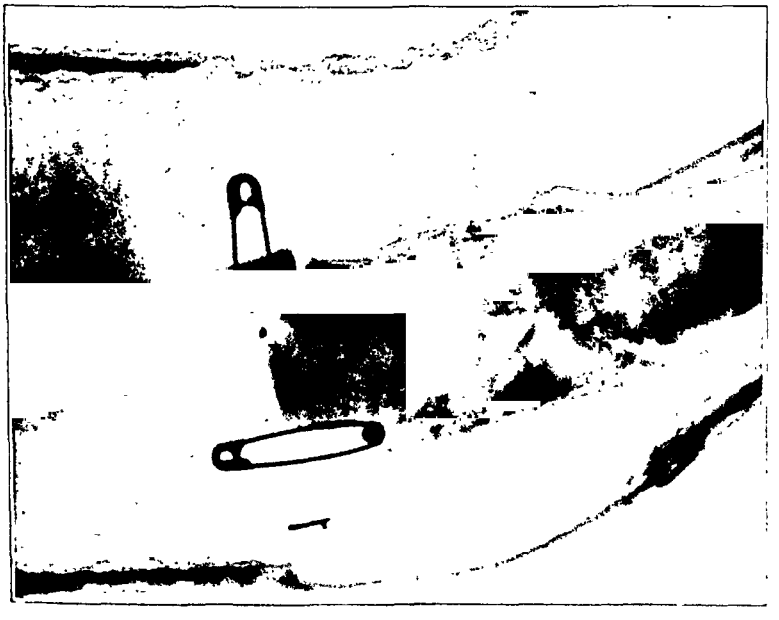


FIG. 6

B. E. Knee in the final position after removal of the turnbuckle.

slightly flexed. Then a flange is outlined so that the angle $OXY$ is approximately a right angle and the line $XY$ is the shortest distance from $X$ to the posterior border of the knee. This short line $XY$ should be chosen in order to minimize posterior projection of the corners $N$ and $M$ (Fig. 4) in the extended position. It is apparent that this flange tends to prevent a backward luxation of the distal fragment in the process of gradual extension. When the flexion deformity is not too great, an extracapsular supracondylar flange osteotomy may be performed without greatly offsetting the long axis of the femur on the tibia. The supracondylar section is technically easy to perform and avoids the lower femoral epiphysis. The following case is illustrative.

## CASE REPORT

B. E., a white girl, twelve years of age, was admitted to the hospital on October 11, 1934, complaining of a deformity of the left knee. The trouble had started eight years previously when the patient had been treated in a New York hospital for tuberculosis of the knee.

Examination showed the knee ankylosed in flexion and carrying scars from previous operations. A diagnosis of old tuberculosis of the knee with flexion deformity was made, and an osteotomy was recommended.

On November 2, 1934, under tourniquet, a lateral incision about four inches long was made over the outer aspect of the lower third of the femur. The quadriceps femoris and the tensor fasciae latae were retracted and the vastus lateralis was split anterior to



FIG. 5

B. E. Before operation.

# THE TREATMENT OF SLIPPING OF THE UPPER FEMORAL EPIPHYSIS WITH MINIMAL DISPLACEMENT *

BY PHILIP D. WILSON, M.D., NEW YORK, N. Y.

The subject of slipping of the upper femoral epiphysis is so large that the author proposes to confine this paper to a discussion of the following points:

1. The treatment of early stages of slipping.
2. The effect of operative fusion of the upper femoral epiphysis upon growth of the lower extremity.

## THE TREATMENT OF THE EARLY STAGES OF SLIPPING

It is trite to remark that the best time to treat a disease is from the beginning, but this statement is so true of slipping of the upper femoral epiphysis that it needs to be emphasized. The earliest stages of slipping almost always give rise to symptoms which, if the physician is alert, can be recognized and will lead to the correct diagnosis. Given a patient between the ages of ten and sixteen years, complaining of intermittent pain and stiffness in the knee or thigh with at times a noticeable limp, one should consider slipping of the epiphysis as one of the first possibilities. Nor should one be led astray by the frequent localization of pain at the inner side of the knee into making only a local examination of that part; a thorough examination of the entire extremity should be made. Guarding or limitation of motions of internal rotation and of abduction of the hip are characteristic of epiphyseal slipping and can be demonstrated almost invariably. Shortening of slight amount may or may not be present, but it is not essential for a diagnosis. Since approximately 70 per cent. of the patients are overweight, the association of these symptoms with obesity in childhood should especially lead one to suspect the condition.

Suspicion of a pathological lesion of the hip will lead to a roentgenographic examination, and an accurate diagnosis can then be made. The irregular rarefaction of the metaphyseal zone of the neck in immediate contact with the epiphyseal cartilage, giving a characteristic appearance of widening of the epiphyseal line, is always evident, especially upon comparison with the normal hip. This may or may not be associated with evidence of displacement as shown by a change in the relationship of the epiphysis to the neck.

The diagnosis of slipping of the upper femoral epiphysis at an early stage, when the displacement is still minimal and not sufficient to cause any permanent functional impairment, permits an entirely different type of treatment from that which is necessary when serious deformity is present. An operation to realign the epiphysis may be avoided, and the

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 20, 1938.

the tensor fasciae latae, exposing the shaft of the femur. The periosteum was incised and elevated. The femoral shaft was drilled twice transversely with a quarter-inch drill, making drill holes one-half an inch apart and parallel to the long axis of the femur in the anterior half of the shaft (Fig. 3, points *O* and *X*). These drill holes were joined with an osteotome. With a saw, on the dorsal surface of the femur slanted from above downward, a wedgelike cut was made to join the superior drill hole (Fig. 3, line *BO*). With a Gigli saw passed beneath the femur, a section was made transversely to join the distal drill hole (Fig. 3, line *YX*). With an osteotome, an anterior wedge (Fig. 3, line *AOB*) was removed, using the superior drill hole as the axis until full correction of the deformity was obtained. The wound was sutured in layers. A plaster spica was applied with the flexion corrected to allow a strong pulsation of the popliteal artery.

On November 10, 1934, hinges were inserted into the cast and further correction was started. On November 17, the deformity had been completely overcome, and, on November 24, the turnbuckles were removed and plaster was applied to maintain the corrected position. One month later the fragments felt strongly united, but splintage was maintained until March 27, when walking without support was instituted.

Final roentgenograms (Fig. 7) were made on February 10, 1937, which show the end result of this operative procedure.

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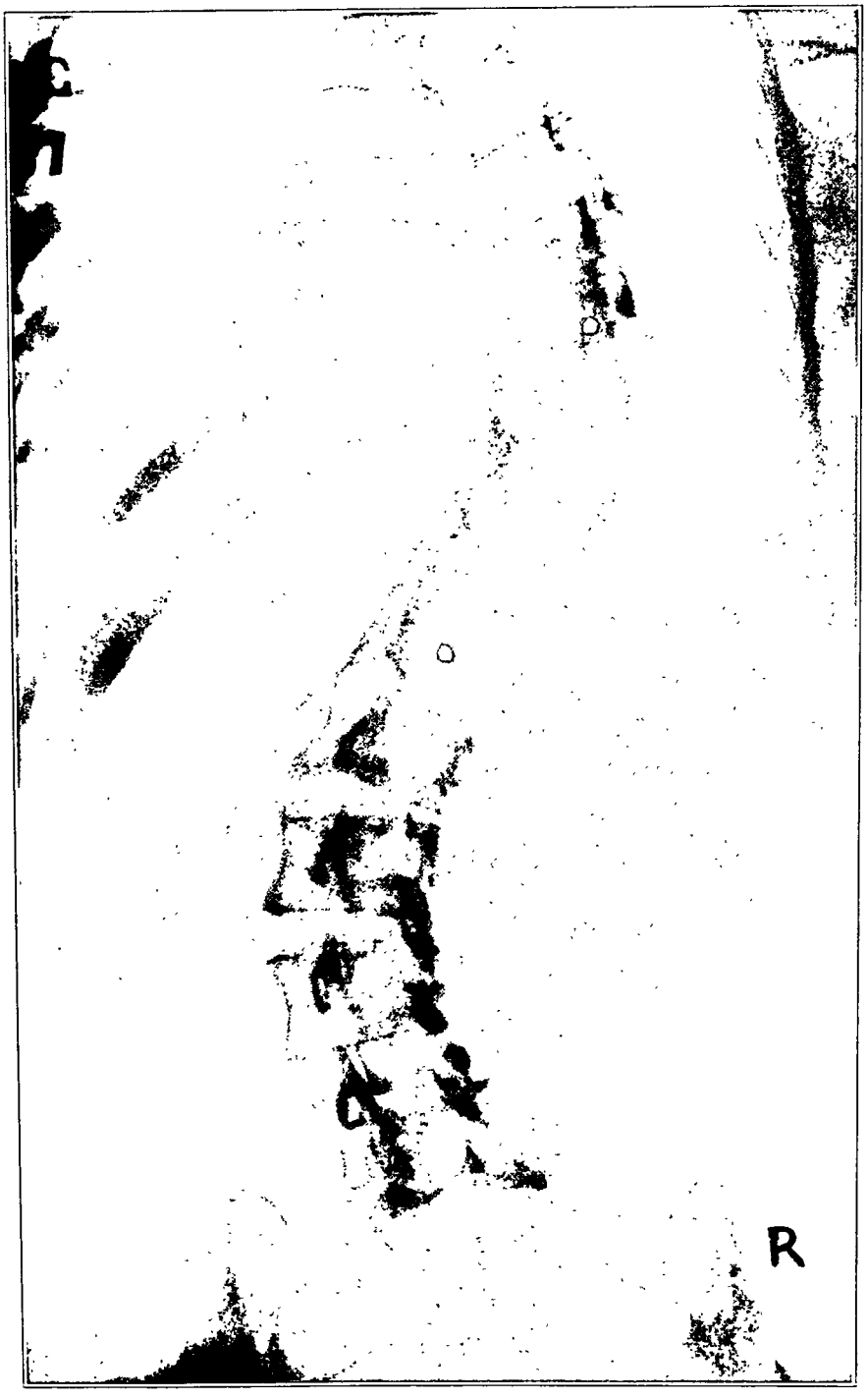



FIG. 16

Case 5. Three years and ten months after operation, with patient standing.

outlook for complete functional restoration is infinitely better. Since the physician who is usually first consulted by the patient is the general practitioner, and since so much depends upon his recognizing the condition in its earliest stage, we orthopaedic surgeons have a duty to see that he is made familiar with the pathological and clinical appearances of the disease and that adequate instruction on this subject is given to the students in our medical schools.

It is inaccurate to describe these cases of early slipping as "preslipping" or "without displacement". Real slipping occurs as soon as the epiphysis is loosened, and without slipping it is doubtful if there would be any symptoms. As was stated by Milch, the first step in the mechanism of displacement is anteversion of the neck in relation to the epiphysis, which produces the characteristic fixed external rotation of the extremity. Only later does the upward displacement of the neck take place, resulting in the typical deformity with the capital epiphysis lying posteriorly and inferiorly.

The difference, then, between a case of early slipping and one of severe displacement is merely the degree of deformity. Any attempt, therefore, to fix a boundary between the displacement that is of no serious functional significance and that which is must be purely arbitrary and approximate. In making a decision one should be guided, not only by the roentgenographic examination, but also by the clinical evidence. More information as to the amount of displacement is usually to be obtained from the lateral roentgenogram than from the films made in the anteroposterior plane. When in the anterior view the upper border of the epiphysis appears well above the upper surface of the neck and in the lateral view the epiphysis has not displaced posteriorly more than one-third of the diameter of the neck, then, the author believes, the deformity may be safely accepted.

The writer has followed a number of patients who showed this amount of displacement and has seen them recover normal function with the exception of a slight loss of internal rotation. Important information in respect to the amount of deformity can also be obtained from the clinical examination. When there is free abduction and not more than 10 degrees of fixed external rotation of the hip, no disability will result provided that any further slipping is prevented.

Having made a diagnosis of slipping of the upper femoral epiphysis, and having determined that the amount of displacement does not exceed the above limits, what is the best plan of treatment? In previous communications by Waldenström, Ferguson and Howorth, and the author, it was pointed out that sound healing was not obtained until the epiphysis was fused to the neck and the epiphyseal cartilage became obliterated. The method of treatment which will most surely and rapidly accomplish this result, without risk of further displacement, is, therefore, the one to be preferred. The writer has made a thorough trial of weight-bearing caliper braces and ambulatory plaster spicas as protective devices and has rejected them as inefficient and dangerous. He has seen complete dis-

placement of the epiphysis occur in patients who were being treated by these methods. Recumbent treatment in a plaster spica is open to criticism on the grounds of uncertainty. It must be continued until epiphyseal fusion is obtained, and this may be a year or more. The author has seen recurrence of symptoms in a patient eleven months after immobilization in plaster was begun. Long-continued fixation is also harmful because of the ensuing atrophy. Waldenström and Wardle favor the use of continuous extension, but the former expects that such treatment may have to be prolonged for as much as a year in order to obtain healing.

There remain to be considered various methods that aim at obtaining early fusion of the epiphysis. Jahss proposed hammering on the lateral aspect of the trochanter to traumatize the epiphysis, followed by the application of a plaster spica, and reported good results from this treatment. The author distrusts the use of a method whose force cannot be accurately controlled, and feels that it is unlikely that uniform results can be obtained. Ferguson and Howorth advocated drilling through the epiphyseal plate and the insertion of small sliver bone grafts. Their method requires arthrotomy and seems unnecessarily complicated. Multiple drilling through the neck from the trochanter has been done by Bazin and others, but this does not seem an entirely easy or hazardless procedure, and it does not obtain fixation of the epiphysis.

In a previous communication the writer described an operative realignment of the displaced upper femoral epiphysis with fixation by the Smith-Petersen nail. This procedure requires arthrotomy of the hip and is only justifiable in cases with severe displacement. As methods were devised for the fixation of fractures of the femoral neck by the insertion of nails or pins through the trochanter under roentgenographic control without arthrotomy, it was natural to make use of this technique in the treatment of early slipping of the upper femoral epiphysis. The first patient to be treated by this method was operated upon by the author in October 1934, and since that time a total of nine patients have been subjected to the procedure. It has proved admirable for its purpose, and complete functional restoration has been obtained in those cases where the amount of posterior displacement of the epiphysis did not exceed the limit of acceptable deformity as previously explained.

The writer employed the Smith-Petersen nail as the instrument of internal fixation and made use of Wescott's technique for introducing it. Reduction was not attempted. Under general anaesthesia an incision was made over the lateral aspect of the trochanter, and the nail was started at a point about one inch below the ridge for the insertion of the vastus lateralis. The leg was held by an assistant, with the hip internally rotated as much as possible, and the nail was driven home at the angle and to the depth previously determined from measurement of the roentgenograms of the hip. The direction of the nail was controlled by roentgenographic examination in both the anteroposterior and lateral planes during the course of the operation. On the whole, the procedure is

simple, although, because of the posterior displacement of the head, there is more need for accurate roentgenographic control in the lateral plane than in the case of a fractured femoral neck.

After closure of the wound and the application of a firm dressing, the patient was returned to bed without any external splinting. The postoperative discomfort was slight and the patient was allowed to be up at the end of one week. The author does not know how soon these patients may be permitted to bear full weight on their hips and he has erred on the side of safety. They were required to walk with crutches and a raised shoe on the sound side until the end of eight weeks. After this period full activities were permitted, with the exception of rough sports.

The use of the nail in these cases serves two purposes. It fixes the epiphysis and thus prevents any possibility of further displacement; and it also penetrates the cartilaginous plate and allows the ingrowth of reparative elements, thus promoting healing and early fusion of the epiphysis. Study of the progress of the healing by roentgenographic observation shows that obliteration of the epiphyseal cartilage is usually obtained in from four to six months. Later removal of the nail seems advisable, although there has been no evidence that any irritation was caused by it. The writer has made a practice of doing this usually at the end of about nine to twelve months. This is a simple operation, not involving a lay-up of more than a few days, which, nevertheless, constitutes the chief disadvantage of the method. The simplicity and security of the procedure, together with its avoidance of postoperative splinting and its great saving of time for the patient, are such positive advantages that they far outweigh this one objection.

Two points should always be remembered in the treatment of patients with early slipping of the upper femoral epiphysis. The first is that the patient's condition should be considered as urgent from the mo-

TABLE I

MEASUREMENTS OF SHORTENING OF LEGS IN PATIENTS WHOSE EPIPHYSES WERE NAILED

| Case No. | Name | Sex | Involvement | Age at First Operation (*Years*) | Preoperative Shortening (*Inches*) | Shortening at Last Measurement (*Inches*) | Postoperative Period (*Months*) |
|---|---|---|---|---|---|---|---|
| 1 | A. M. | Male | Unilateral | 12 | ½ | ½ | 34 |
| 2 | D. W. | Female | Bilateral | 12 | ½ | ½ | 31 |
| 3 | W. Y. | Female | Unilateral | 12 | 0 | 1 | 27 |
| 4 | G. W. | Female | Bilateral | 10 8/12 | 0 | 0 | 18 |
| 5 | D. F. | Male | Unilateral | 16 | ½ | 0 | 16 |
| 6 | H. P. | Male | Unilateral | 12 7/12 | ¼ | 0 | 13 |
| 7 | J. B. | Male | Unilateral | 14 6/12 | 0 | 0 | 13 |
| 8 | R. F. | Female | Unilateral | 12 8/12 | 0 | ½ | 5 |
| 9 | C. S. | Male | Unilateral | 15 6/12 | ¼ | ¼ | 4 |

ment that the diagnosis is made or even suspected. The author can recall several instances where the physician did not insist upon immediate treatment and the patients returned home only to be brought back to the hospital a few days later by ambulance because a slight misstep or fall had resulted in a complete separation of the epiphysis. The outlook for the patient who is treated in the early slipping stage is so far superior to that of one with complete displacement that no risk of the former condition's being converted into the latter should be permitted. Until the epiphysis is nailed, the only safe place for the patient is in bed with extension to the leg, and any delay in instituting such treatment is dangerous.

The other point is that the possibility of bilateral involvement of the hips should be constantly kept in mind. The patient and his parents should be warned to report the slightest suspicious symptoms arising on the unaffected side, and, as an extra safeguard, both hips should be included in the roentgenographic examination as often as this is required. In this way slipping of the other epiphysis can be recognized and treated while still in a favorable stage.

## THE EFFECT OF FUSION OF THE UPPER FEMORAL EPIPHYSIS UPON GROWTH OF THE LOWER EXTREMITY

One of the first questions that arose in connection with the treatment of slipping of the upper femoral epiphysis by the insertion of a nail or pin was: "What would be the effect of early fusion of this epiphysis upon the growth of the extremity?" Although at the time the author was unable to answer this question, he soon satisfied himself that it was largely academic, since the review of a series of roentgenograms of patients treated in plaster without operation showed that the epiphyseal cartilage fused early in any case. Subsequent follow-up examination of the patients whose hips were nailed was reassuring and showed that serious shortening of one extremity did not develop. The measurements of inequality in length prior to operation and at the last follow-up observation in the nine patients whose epiphyses were nailed are shown in Table I. It will be seen that four patients showed no shortening; one had shortening of one-quarter of an inch; three, of one-half an inch; and one, of one inch. Of the five patients with shortening, three showed the same amount as had existed before operation and only two with legs of equal length in the beginning showed later inequality. Two patients with slight inequality before operation made good the deficiency and later had legs of equal length. The greatest amount of shortening was one inch in one patient and this did not increase in the last eighteen months.

It is of interest to try to explain these rather surprising observations. Digby, in his studies of the growth of the long bones, gave the figures for the femur and the tibia shown in Table II.

While both Gray and Piersol give the time for the closing of the upper femoral epiphysis at about eighteen years, Cohn, whose conclusions were drawn from the study of a series of roentgenograms, fixed it at approxi-

TABLE II

GROWTH OF BONES OF LOWER EXTREMITY (DIGBY)

| Epiphyseal Region | Amount of Growth | Percentage of Growth |
|---|---|---|
| Upper end of femur | 5.0 inches | 17.2 |
| Lower end of femur | 11.0 inches | 37.8 |
| Upper end of tibia | 7.5 inches | 25.8 |
| Lower end of tibia | 5.6 inches | 19.2 |
| Total | 29.1 inches | 100.0 |

mately fifteen years, and this is probably the more reliable figure. Since this epiphysis contributes approximately 17 per cent. of the total growth of the lower extremity, and since slipping of the upper femoral epiphysis occurs between the ages of ten and sixteen years with an average age of about thirteen years, one is forced to conclude that the absence of serious shortening is due either to a precocious closing of the corresponding epiphysis on the unaffected side or to the fact that most of the growth from the upper femoral epiphysis takes place early and diminishes to a small amount after the age of twelve years. While Cohn's studies support the latter hypothesis and this affords an adequate explanation in children belonging to the older age group, it does not seem sufficient in those of from ten to twelve years. The author's own observations show that closure of the unaffected epiphysis usually takes place within two years after the appearance of slipping, which is frequently considerably in advance of the normal time. Precocious closure of this epiphysis lends confirmation to the theory that epiphyseal slipping is the result of metabolic disorder.

Another question that has been raised in connection with early closure of the upper femoral epiphysis has to do with the effect of continued growth of the epiphysis for the greater trochanter upon the gradual reduction of the angle of the femoral neck. It was suggested that the trochanteric region of the femur would continue to grow and that with the capital epiphysis closed, resulting in a stationary position of the head, a gradual ascent of the greater trochanter would take place with the production of a coxa-vara deformity. The writer reviewed a series of late roentgenograms in a group of patients upon whom operative replacement of the epiphysis and nailing had been performed some time earlier and was inclined to agree that there was some confirmation of this theory. Acting upon this belief, in 1934 he fused the epiphysis for the greater trochanter in two patients at the same time that he nailed the capital epiphysis. (See Cases 1 and 3.) These patients have now been followed thirty-four and twenty-seven months respectively and, while they show no change in the angle of the neck with the shaft, neither do any of the other patients in whom nailing of the capital epiphysis alone was done. Therefore, the writer is unable to demonstrate in the period of time that has thus far

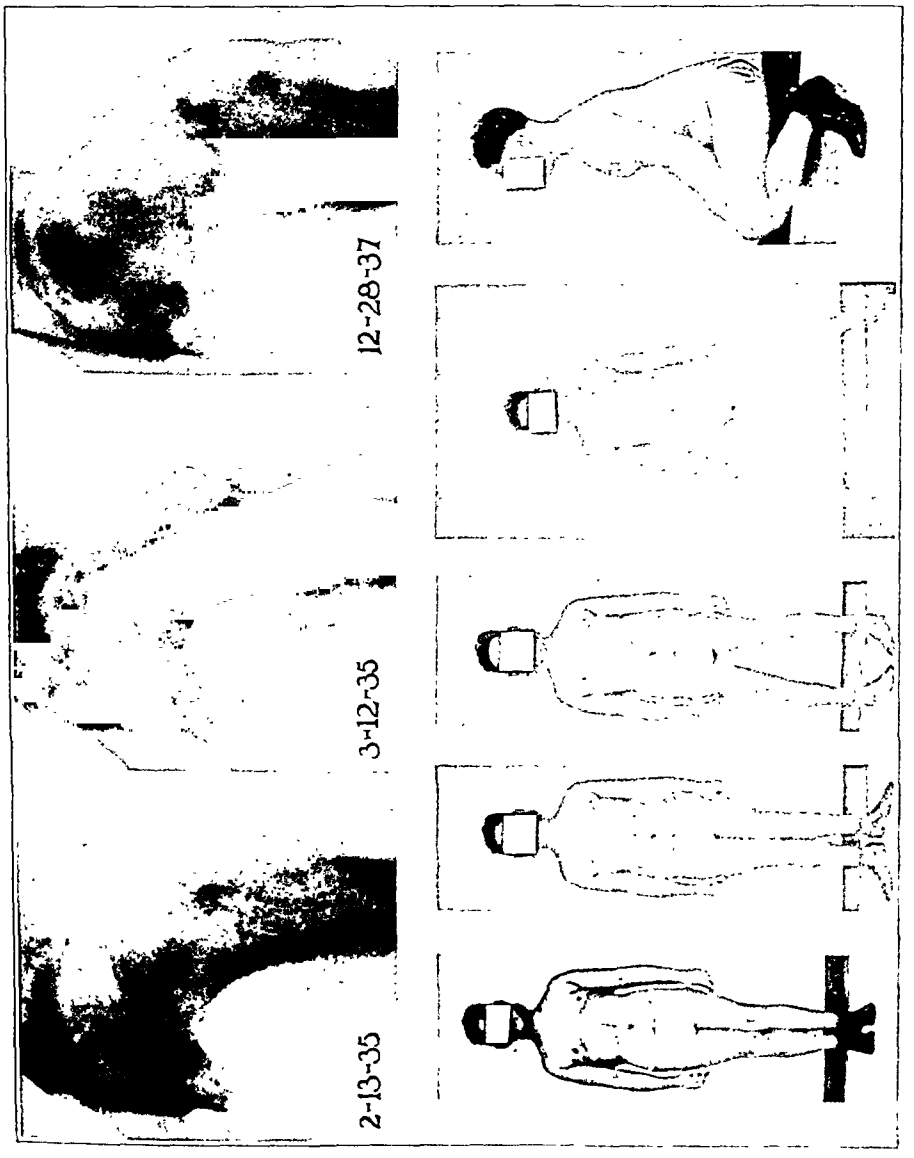



FIG. 1—Case 1.

FIG. 2—Case 2.

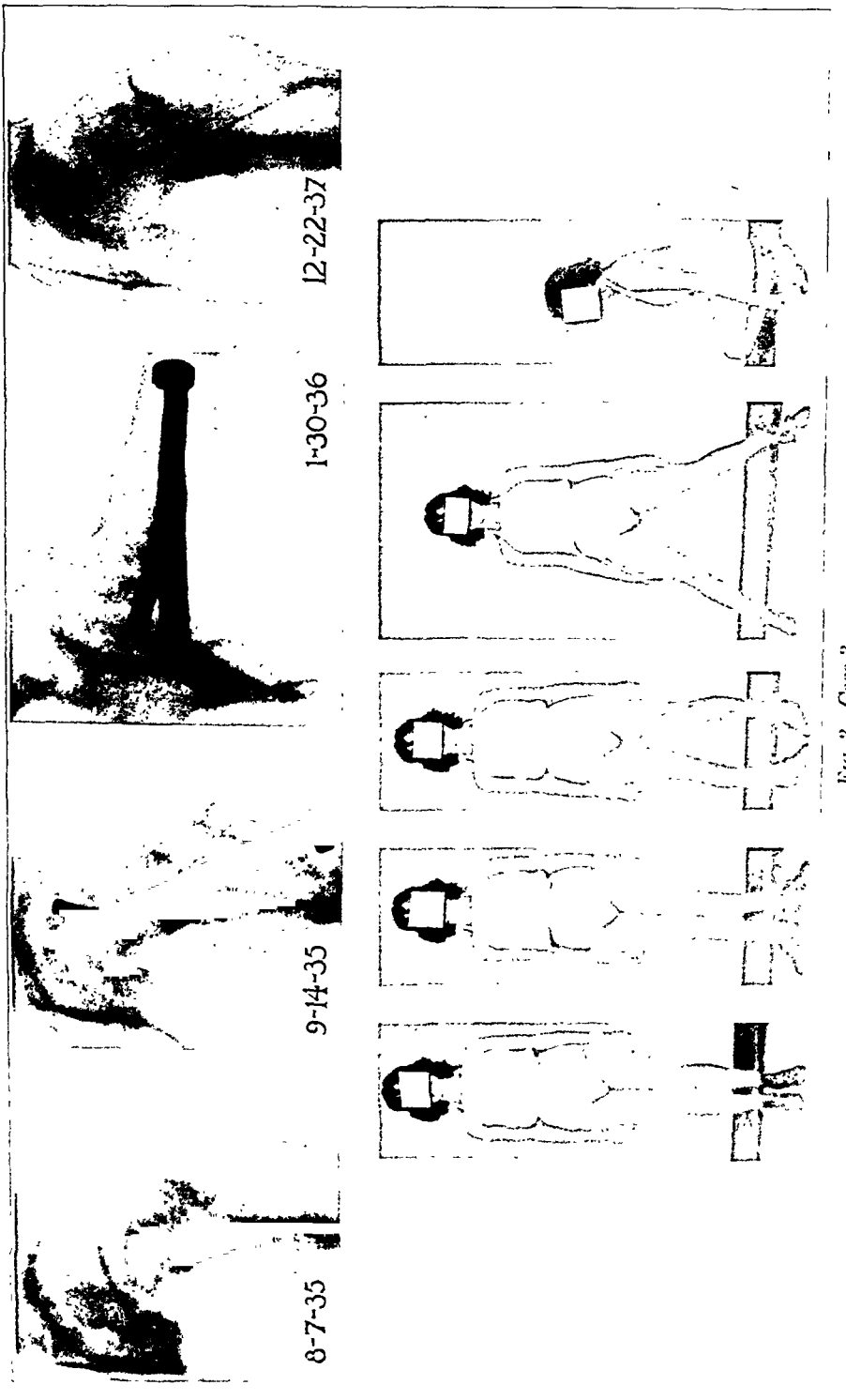



FIG. 3—Case 3.

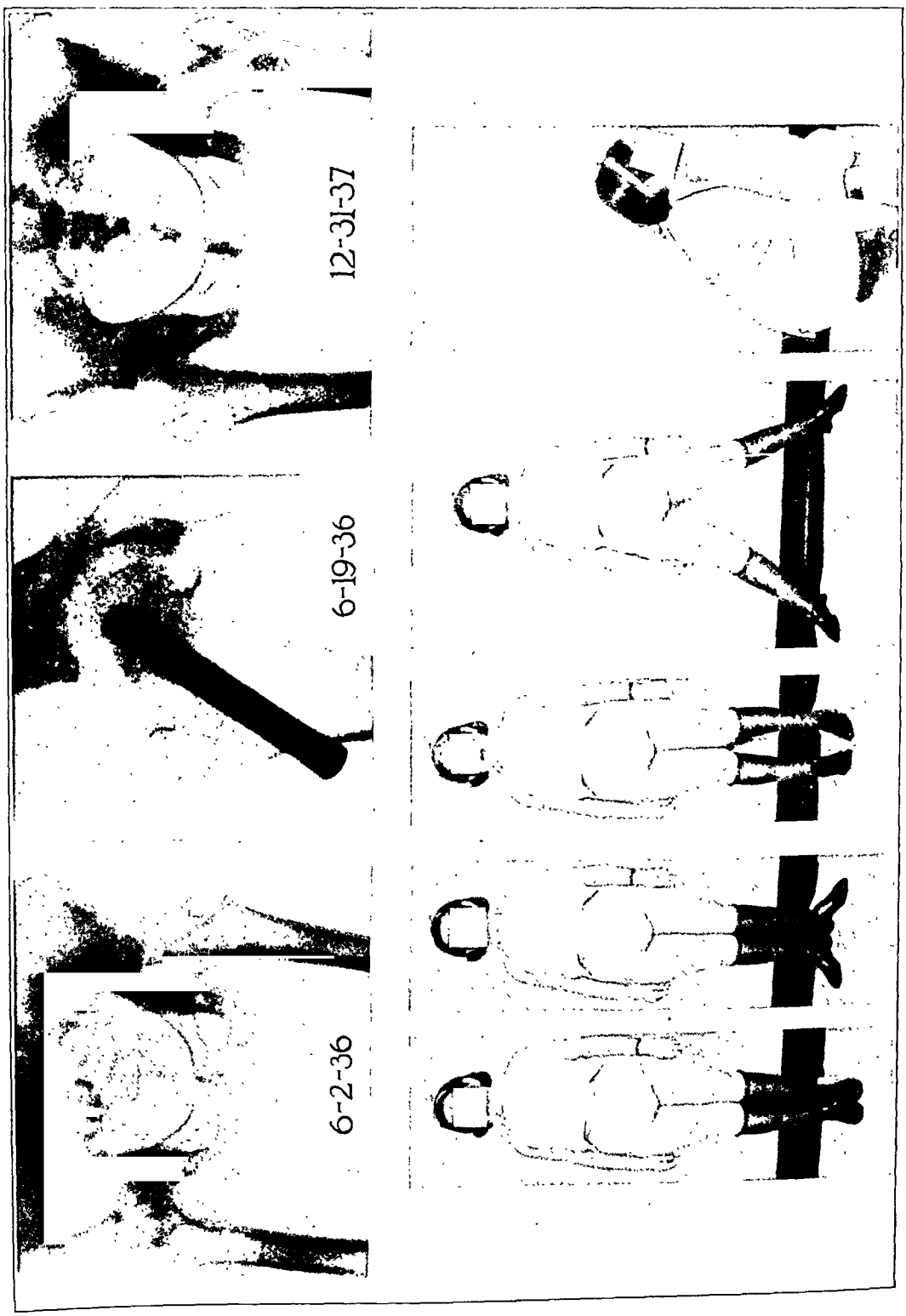



FIG. 4—Case 4.

elapsed that there is any advantage to the patient in this particular procedure.

## CASE REPORTS

CASE 1 (H17-949). A. M., male, aged twelve, was admitted on February 11, 1935, with a history of a fall four months previously, followed by increasing pain in the left leg and a limp. Physical examination showed an obese boy of the "Fröhlich" type, with slight limitation of abduction and internal rotation of the left hip. There was one-half an inch of shortening of the left leg. Roentgenographic examination on February 13, 1935, showed widening of the epiphyseal line, but only slight displacement of the femoral head. A diagnosis of slipping of the upper femoral epiphysis was made and operation was advised.

On February 20, 1935, under general anaesthesia, an incision was made over the lateral aspect of the greater trochanter, and a Smith-Petersen nail was inserted following Wescott's technique. An epiphysiodesis of the trochanteric epiphysis was also done. The patient was kept in bed one month and was then permitted up with a one-inch lift on the right shoe and crutches, which he continued to use for four months. He then resumed full activities.

The nail was removed on October 11, 1935, eight months after insertion. When seen on December 22, 1937, thirty-four months after nailing, the patient had no complaints or disability. Examination showed no appreciable limitation of motion of the left hip. There was shortening of one-half an inch. The measurements were as follows:

| | *Left* | *Right* |
|---|---|---|
| Length | 34½ inches | 35 inches |
| Abduction | 45 degrees | 35 degrees |
| External rotation | 50 degrees | 40 degrees |
| Internal rotation | 15 degrees | 20 degrees |
| Flexion | 135 degrees | 135 degrees |
| Extension | Normal | Normal |

CASE 2 (H19-030). D. W., female, aged twelve, was admitted on May 20, 1935. The patient complained of pain in the left hip of five weeks' duration which began insidiously and without injury. Physical examination showed an overweight girl with a limp on the left side and limitation of internal rotation and of abduction of the left hip. There was one-half an inch of shortening of the left leg. Roentgenographic examination showed rarefaction at the epiphyseal line and slight posterior displacement of the femoral head.

On May 22, 1935, an operation was performed under ether anaesthesia. The epiphyseal cartilage was drilled in several places, and small sliver bone grafts were inserted in the drill holes. The patient made an uneventful recovery and was discharged on June 25, 1935. She walked with the aid of crutches until the end of eight weeks and then resumed full activities.

In March 1936, she began having stiffness and fatigue in the right lower extremity. There was a slight limp, but no restriction of motion and no shortening. Roentgenographic examination showed rarefaction along the line of the right capital epiphysis, but no demonstrable displacement. The left capital epiphysis was united.

She was readmitted to the hospital and, on March 21, 1936, an operation on the right hip was performed. A Smith-Petersen nail was inserted through a lateral incision over the trochanter under roentgenographic control. The patient was discharged, and walked with crutches for five weeks; she was then permitted full activities. She was readmitted to the hospital approximately one year later, and the nail was removed.

When examined on December 22, 1937, she complained of only an occasional "weather pain", but was conscious of no disability. There was one-half an inch of shortening of the left lower extremity. All motions of both hips were painless and free. Roent-

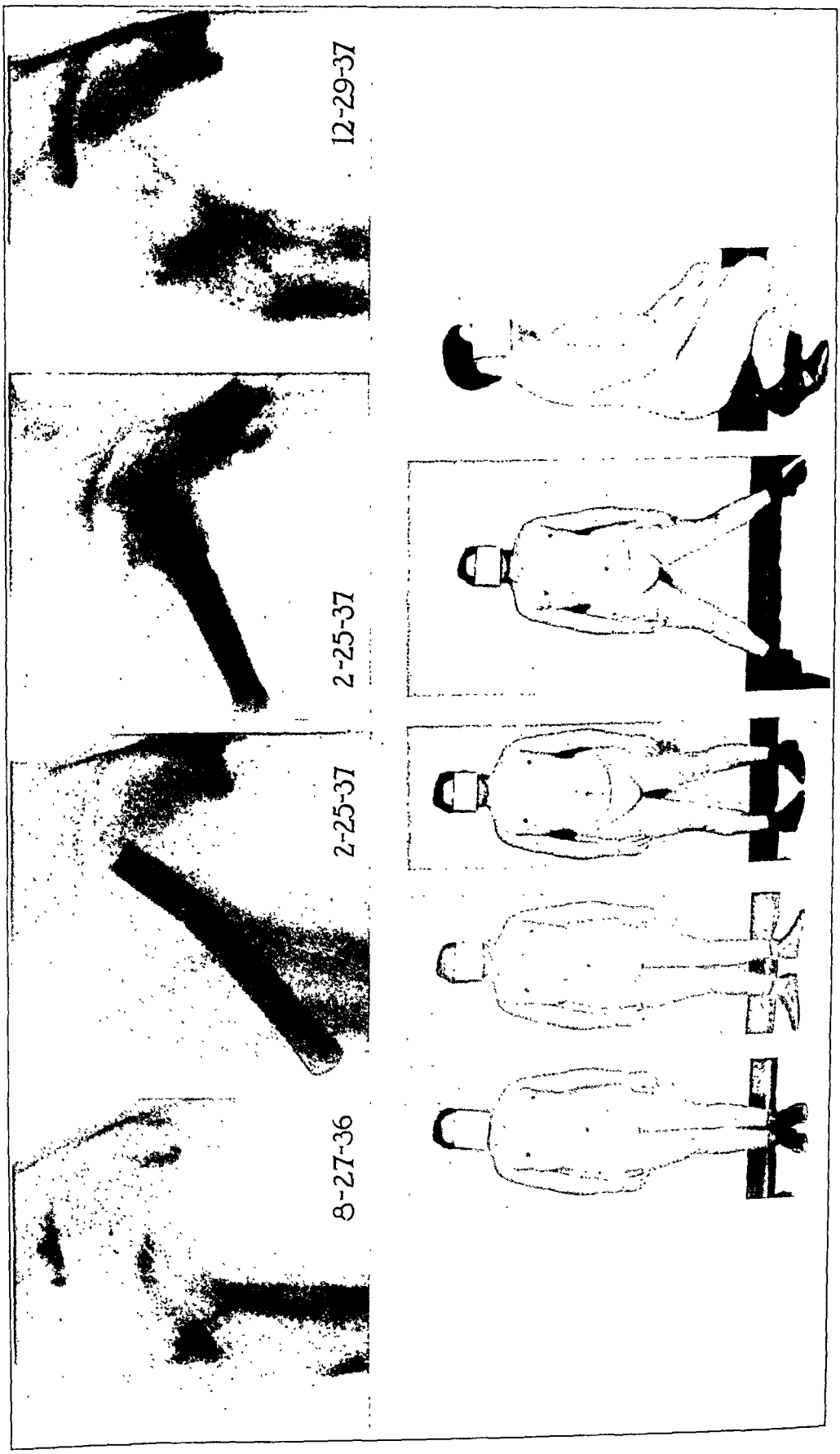



FIG. 5—Case 5.

genographic examination showed both capital epiphyses to be fused. The comparative measurements were as follows:

| | *Left* | *Right* |
|---|---|---|
| Length | 34½ inches | 35 inches |
| Abduction | 33 degrees | 40 degrees |
| External rotation | 55 degrees | 35 degrees |
| Internal rotation | Normal | Normal |
| Flexion | Normal | Normal |
| Extension | Normal | Normal |

CASE 3 (H14-917). W. Y., female, aged twelve, was admitted on August 12, 1935. The patient gave an indefinite history of a fall from a swing, followed by pain and limp of the left leg of six weeks' duration. Examination showed an obese girl in good physical condition. The left lower extremity was held in a position of external rotation and could not be internally rotated to beyond a neutral position. The leg length was equal. Other motions of the hip were free. Roentgenograms, taken on August 7, 1935, showed slight posterior displacement of the femoral head and widening of the zone of the epiphyseal cartilage.

On September 11, 1935, an operation, consisting of the insertion of a Smith-Petersen nail by Wescott's method, was performed, and an epiphysiodesis of the trochanteric epiphysis was done. The patient was kept in bed for three weeks and was then discharged on crutches. Weight-bearing was not permitted until the end of three months. Roentgenograms on September 14, 1935, and January 30, 1936, showed the nail in good position. The nail was extracted on June 24, 1936, nine and one-half months after insertion.

When last examined on December 22, 1937, twenty-seven months after nailing, the patient presented no complaint or disability. There was one inch of shortening of the extremity. The range of motion of the operated hip was entirely comparable with that of the normal hip, and there was normal musculature. The roentgenogram showed both capital epiphyses fused.

CASE 4 (H23-249). G. W., female, aged ten years and eight months, was admitted on June 1, 1936, complaining of pain in the right hip and lameness of about one year's duration. The onset was gradual without history of injury. Examination showed a short, obese girl walking with a marked right-sided limp. The right hip was held in fixed external rotation of 20 degrees and in slight adduction. All motions of the hip were limited and guarded. The leg length was equal. The roentgenographic examination showed moderate downward and marked posterior displacement of the capital epiphysis. Operative realignment was advised.

Operation was performed on June 3, 1936. The hip was exposed by a goblet-shaped incision, extending downward and laterally from the anterior superior spine and separating in the plane between the tensor fasciae femoris and the sartorius. The capital epiphysis was found lying posteriorly but firmly united to the neck. It was separated with a chisel without injuring the ligamentum teres. The neck was trimmed to fit accurately and was then replaced in normal relation to the head. A Smith-Petersen nail was driven up through the trochanter, solidly fixing the head. The wound was closed, and the patient was returned to bed with light adhesive extension to the leg. At the end of two weeks the extension was discontinued and active exercises were started, but without weight-bearing. The patient was allowed up on crutches with a raised sole on the opposite shoe. Mobility of the hip was rapidly recovered and the patient was discharged on July 15, 1936. Full weight-bearing was permitted at the end of three months, and she rapidly resumed normal activities.

She was readmitted to the hospital on July 19, 1937, for removal of the nail. At this time the roentgenographic examination showed solid fusion of the right femoral epiphysis, but widening of the epiphyseal-cartilage space in the left hip and evidence of beginning slipping. An operation was performed on July 21, 1937, under general anes-

and spine fusion for scoliosis. While in many cases the end results have not been as good as could be desired, and while we are continually striving to improve the technique, yet we feel that this method of treatment in selected cases is entirely worth while and gives more striking permanent improvement than any other method at present known to us. The principles discussed in this paper are important factors in securing such results.

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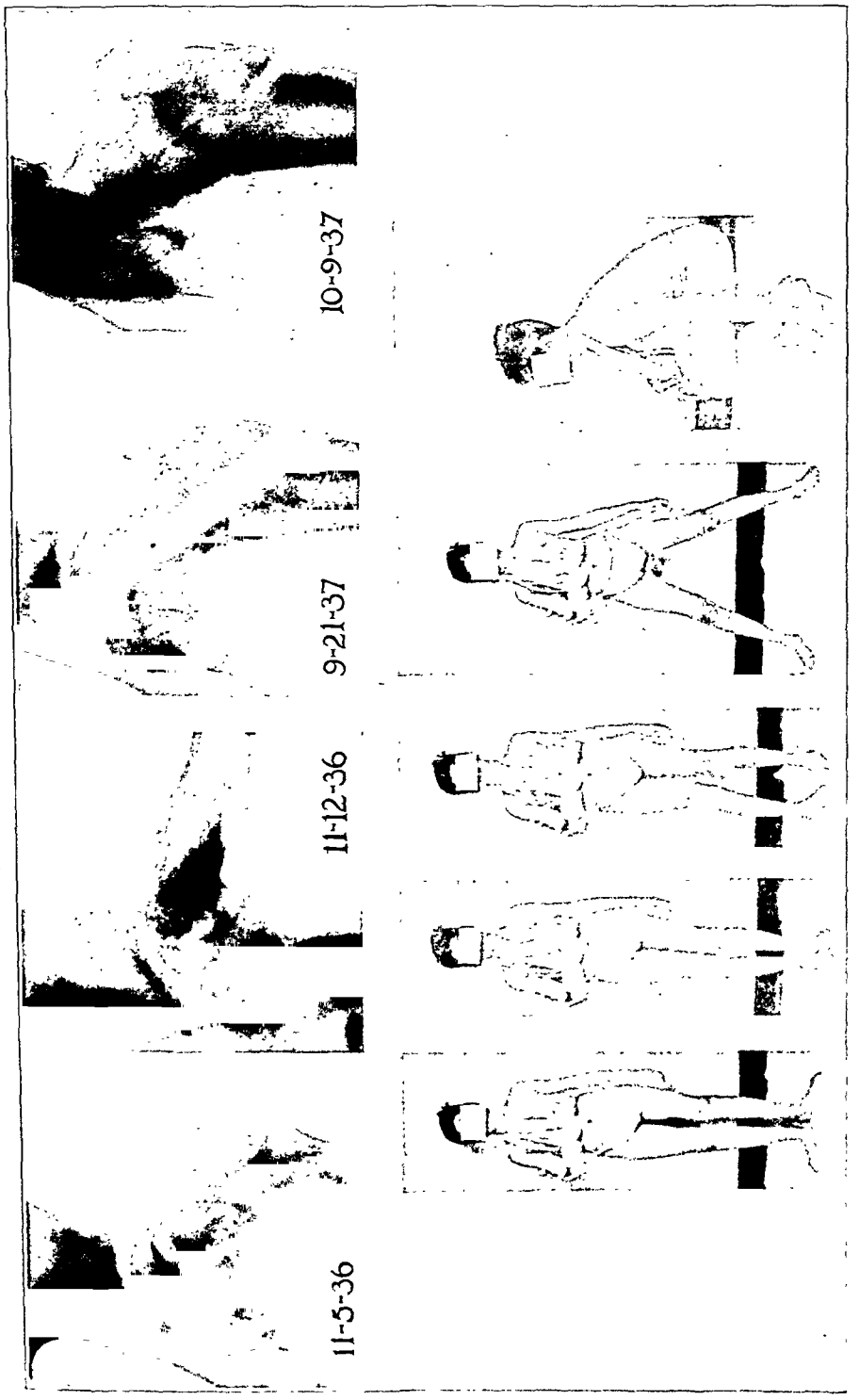



FIG. 7—Case 7.

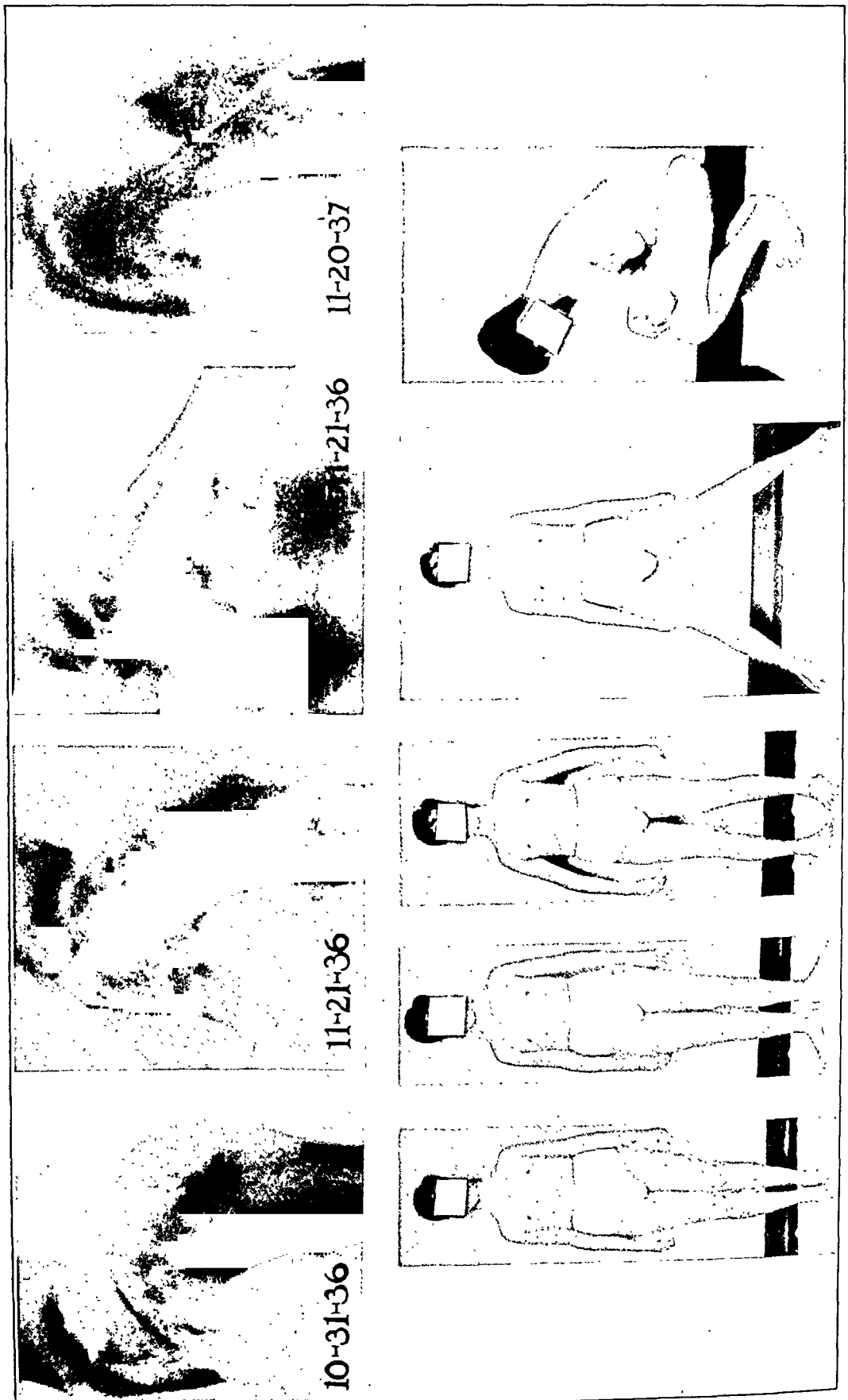



FIG. 6—Case 6.

thesia. Through a lateral incision over the left trochanter, a Smith-Petersen nail was inserted under roentgenographic guidance. A small incision was made over the right trochanter, and the nail on this side was removed. Full mobility of both hips was permitted immediately. The patient was discharged one week after operation, walking on crutches, and full weight-bearing was not allowed until the end of four months.

When last examined on December 31, 1937 (in the illustration the roentgenogram is shown reversed), she had full use of the legs and there was no complaint. The leg length was equal, and there was free and painless motion in both hips. The measurements were as follows:

| | *Left* | *Right* |
|---|---|---|
| Length | 31¼ inches | 31¼ inches |
| Abduction | 30 degrees | 30 degrees |
| Adduction | 20 degrees | 20 degrees |
| External rotation | 50 degrees | 50 degrees |
| Internal rotation | 10 degrees | 30 degrees |
| Flexion | 115 degrees | 117 degrees |
| Extension | Normal | Normal |

CASE 5 (H23–600). D. F., male, aged sixteen, was admitted on August 26, 1936. He gave a history of pain in the right hip of intermittent character for a period of two or three years, but continuous during the previous few months. There was no history of injury. Physical examination showed an obese boy walking with a definite right-sided limp. There was one-half an inch of shortening of the right lower extremity. The right hip was held in slight fixed external rotation, and there was slight limitation of abduction. The other motions were free. The roentgenographic examination revealed a slipped femoral epiphysis with moderate coxa-vara deformity.

An operation was performed on August 28, 1936, and a Smith-Petersen nail was inserted by the Wescott method. After two weeks of hospitalization, the patient was discharged walking on crutches. Full activities were resumed at the end of four months. The nail was removed on May 14, 1937, approximately nine months after insertion.

When last examined on December 22, 1937, sixteen months after nailing, the patient stated that he had participated actively in sports and was entirely well. There was no limp. The leg length was equal, and there was no significant limitation of motion. The roentgenogram showed union of the capital epiphysis and satisfactory position. The measurements were as follows:

| | *Left* | *Right* |
|---|---|---|
| Length | 34 inches | 34 inches |
| Circumference of thighs | 23¾ inches | 23 inches |
| Abduction | 50 degrees | 35 degrees |
| External rotation | 45 degrees | 55 degrees |
| Internal rotation | 10 degrees | 5 degrees |
| Flexion | 135 degrees | 134 degrees |
| Extension | Normal | Normal |

CASE 6 (H24–440). H. P., male, aged twelve years and seven months, was first seen on October 10, 1936, at which time he complained of pain in the lateral aspect of the left knee. Later pain developed in the region of the hip. Examination showed one-fourth of an inch of shortening of the left leg. There was slight restriction of internal rotation and of flexion. Hyperextension was increased. Roentgenographic examination showed early slipping of the left femoral epiphysis.

The patient was admitted to the hospital on November 16, 1936, and nailing through a lateral incision under roentgenographic control was performed on November 18, 1936. He was permitted up a few days later and was discharged on January 2, 1937, walking with a raised shoe on the right and crutches. Full weight-bearing was permitted at the end of two and one-half months, and the patient quickly recovered normal function. He was readmitted one year later and the nail was removed.

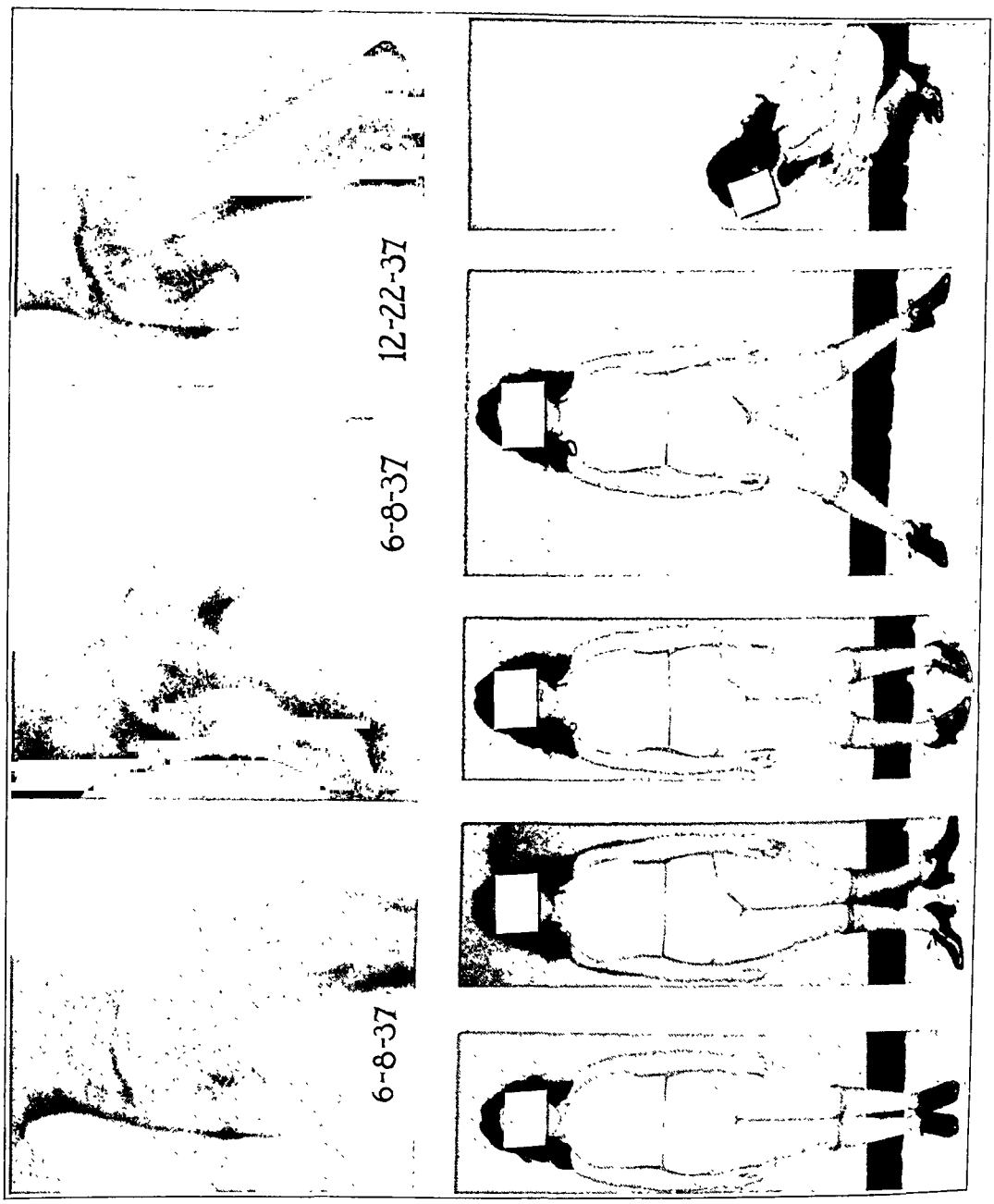



FIG. 8.—Case 8.

When last examined on December 22, 1937, thirteen months after the first operation, he presented no complaints. There was a normal range of motion of the affected hip, and the lower extremities were of equal length. The roentgenogram showed fusion of the capital epiphysis. Comparative measurements of the hips were as follows:

| | *Left* | *Right* |
|---|---|---|
| Length | 34¾ inches | 34¾ inches |
| Abduction | 30 degrees | 43 degrees |
| Adduction | Normal | Normal |
| External rotation | 45 degrees | 45 degrees |
| Internal rotation | 20 degrees | 30 degrees |
| Flexion | 120 degrees | 125 degrees |

CASE 7 (H24–151). J. B., male, aged fourteen years and six months, was first examined in the Clinic on November 9, 1936. He gave a history of pain in the left hip of five weeks' duration, which had begun with a sudden click while walking. Examination showed a slender boy with a left-sided limp. Restriction and guarding of all movements of the left hip were noted. The leg length was equal. Roentgenographic examination showed widening of the epiphyseal line of the left hip with evidence of beginning slipping. The patient was admitted to the hospital immediately, and an operation was performed on November 13, 1936. A Smith-Petersen nail was introduced under roentgenographic guidance by the usual technique without any effort at reposition of the head. A one-inch lift was placed on the right shoe. The patient was permitted to walk with crutches and was discharged on December 10, 1936. He was allowed to walk normally at the end of two months. He was readmitted to the hospital thirteen months after operation, at which time there was fusion of the capital epiphysis, and the nail was removed.

Examination on December 7, 1937, showed normal function and no complaint. The leg length was equal. The comparative measurements of length and hip motion were as follows:

| | *Left* | *Right* |
|---|---|---|
| Length | 34½ inches | 34½ inches |
| Abduction | 42 degrees | 43 degrees |
| External rotation | 45 degrees | 50 degrees |
| Internal rotation | 30 degrees | 35 degrees |
| Flexion | 125 degrees | 120 degrees |
| Extension | Normal | Normal |

CASE 8 (H26-116). R. F., female, aged twelve years and eight months, was first seen in May 1937 because of intermittent pain in the left hip, which had begun one year previously following a fall. Examination showed a large overweight girl who walked with a slight limp on the left. The length of the lower extremities was equal. Slight restriction of abduction of the left hip and slight fixed external rotation were present. The roentgenograms showed slight downward and backward displacement of the left upper femoral epiphysis and irregularity along the epiphyseal cartilage.

The patient was admitted to the hospital on June 7, 1937, and an operation was performed on June 9. Under general anaesthesia and without any attempt at reposition of the head, a lateral incision was made over the greater trochanter and a Smith-Petersen nail was inserted under roentgenographic guidance. Following operation, the patient was kept in bed for four weeks with light extension on the leg, and was then allowed up with a raised sole and crutches. She was discharged on July 17, 1937. Full weight-bearing was permitted at the end of two months.

When last examined on December 22, 1937, she presented no complaints and walked very well. There was one-half an inch of shortening of the left leg with slight limitation of internal rotation. The roentgenogram showed good position and the epiphysis fused. Comparative measurements were as follows:

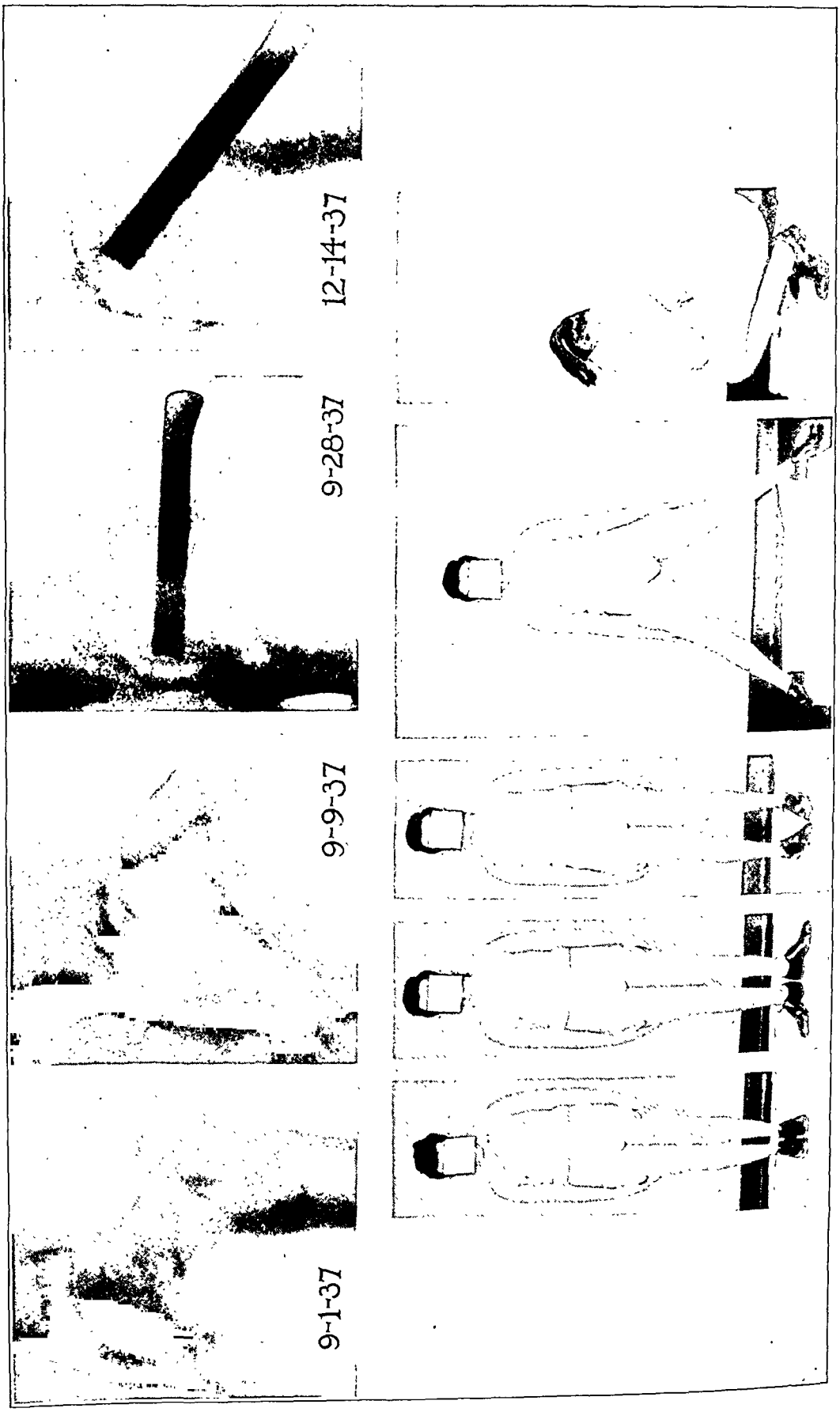



FIG. 9—Case 9.

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| | *Left* | *Right* |
|---|---|---|
| Length | 30 inches | 30½ inches |
| Abduction | 35 degrees | 38 degrees |
| External rotation | 50 degrees | 50 degrees |
| Internal rotation | 10 degrees | 20 degrees |
| Flexion | 140 degrees | 150 degrees |

CASE 9 (H26–882). C. S., male, aged fifteen years and six months, was admitted to the hospital on September 9, 1937, with a history of intermittent but progressive stiffness and pain in the right hip of one year's duration. There was no definite relation to trauma. Examination showed an obese boy, of the hypopituitary type, with slight bilateral knock-knee and a marked left-sided limp. The motions of the left hip were limited in abduction, adduction, and internal rotation. External rotation was normal, and hyperextension was increased. The roentgenographic examination at this time showed rarefaction in the line of the epiphyseal cartilage and slight downward and backward displacement of the femoral head.

An operation was performed on September 17, 1937, and a Smith-Petersen nail was inserted by the usual technique without any attempt to replace the head. The patient was discharged two weeks later on crutches, and weight-bearing was prohibited for three months.

When last examined on December 28, 1937, three and one-half months after nailing, the hip was painless, and there was scarcely any limp. The right extremity showed shortening of one-fourth of an inch, and there was scarcely any appreciable limitation of motion. The roentgenographic examination showed the nail still in place and the epiphysis in good position and beginning to fuse. Comparative measurements were as follows:

| | *Left* | *Right* |
|---|---|---|
| Length | 35¼ inches | 35½ inches |
| Abduction | 30 degrees | 35 degrees |
| Adduction | 15 degrees | 15 degrees |
| External rotation | 45 degrees | 40 degrees |
| Internal rotation | 0 degrees | 5 degrees |
| Flexion | 120 degrees | 125 degrees |

## SUMMARY

The diagnosis of slipping of the upper femoral epiphysis at an early stage, when the displacement is still minimal and not sufficient to cause any permanent functional impairment, permits an entirely different type of treatment from that which is necessary when serious deformity is present. Since early diagnosis depends chiefly upon the general practitioner, there is need of better instruction in the pathological and clinical appearances of this disease.

For epiphyseal slipping with minimal displacement the author advocates the insertion of a Smith-Petersen flanged nail under roentgenographic control, without arthrotomy of the hip. The advantages of this method are security and fixation, hastening of epiphyseal fusion, freedom from immobilization, and simplicity of after-care. This operation has been performed in nine cases with excellent results in all. Significant shortening of the extremity did not occur.

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# TUBERCULOUS OSTEITIS OF THE ISCHIUM

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*From Apelviken Coast Sanatorium,* Varberg, Sweden*

As tuberculous osteitis of the ischium seems to be little known, and as only occasional cases have as yet been published, the author feels justified in giving a short account of the eight cases which were treated at Apelviken Coast Sanatorium from 1928 to 1936; these constituted 0.2 per cent. of the cases of bone tuberculosis treated during this period. At the same time, five other cases of osteitis of the ischium, of uncertain etiology, were treated. Three of these are probably to be denoted as cases of clear septic osteitis, while the origin of the other two cases is uncertain. Only a short account of these will be given in connection with the differential diagnosis.

Of the patients suffering from tuberculous osteitis of the ischium six were male and two were female. In five cases the left ischium was the seat of the tuberculous infection; in three cases the site was the right ischium.

The course of tuberculous osteitis of the ischium is insidious and protracted. In the cases upon which this report is based it made its first appearance as slight pain of the sciatica type. In one case (Case 5) the pain started after trauma, and in one case (Case 3) the symptoms set in after childbirth. (As a matter of fact, it has often been observed that a previously latent bone tuberculosis flares up in close connection with childbirth.) During the course of the disease also, the pain, which in most of the cases lasted for a year or more, was of a very mild type, so that the patient was able to go about his work as usual. Later on, however, *localized pain* over the tuber ischii was present; this was especially pronounced when the patient was seated. However, in most cases the pain did not cause much discomfort.

Gradually, abscesses or fistulae appeared in the gluteal region, and not until then did the patient seek medical aid. In one or two rare cases these subjective symptoms occurred periodically, with shorter or longer intervals without symptoms. In one case (Case 2) a fistula appeared in the gluteal region coincident with the setting in of the pain. In nearly all cases the clinical examination showed tenderness to palpation over the tuber ischii, which could also be felt to be raised and thickened.

In two cases (Cases 3 and 5) the patient also had subjective symptoms from the hip joint of the same side as the affected ischium. These symptoms consisted of a sensation of stiffness in the hip joint, at times associated with pain, radiating from the hip joint down along the leg. In addition, it was possible at the *clinical examination* to establish a

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# LATERAL INTRODUCTION OF THE SCREW-BOLT IN INTRACAPSULAR FRACTURE OF THE HIP *

BY MYRON O. HENRY, M.D., MINNEAPOLIS, MINNESOTA

In 1932, the author devised a rustless-steel screw-bolt for fixing the head onto the shaft in true intracapsular fracture of the hip, a principle of treatment previously shown to be sound in animal experimentation [1]. The original method [2] afforded excellent visualization of the fracture, permitted removal of interposed soft tissues, and enabled accurate introduction of the screw-bolt. Although close coaptation of the fragments was secured, the method required a major surgical operation which could be conscientiously advised in only a few selected cases. While internal fixation under direct exposure has many enthusiastic supporters, there has been a continuous search for a satisfactory means of introducing reliable fixation by a less extensive lateral surgical exposure. The sound mechanics of the screw-bolt principle for internal fixation of fractures of

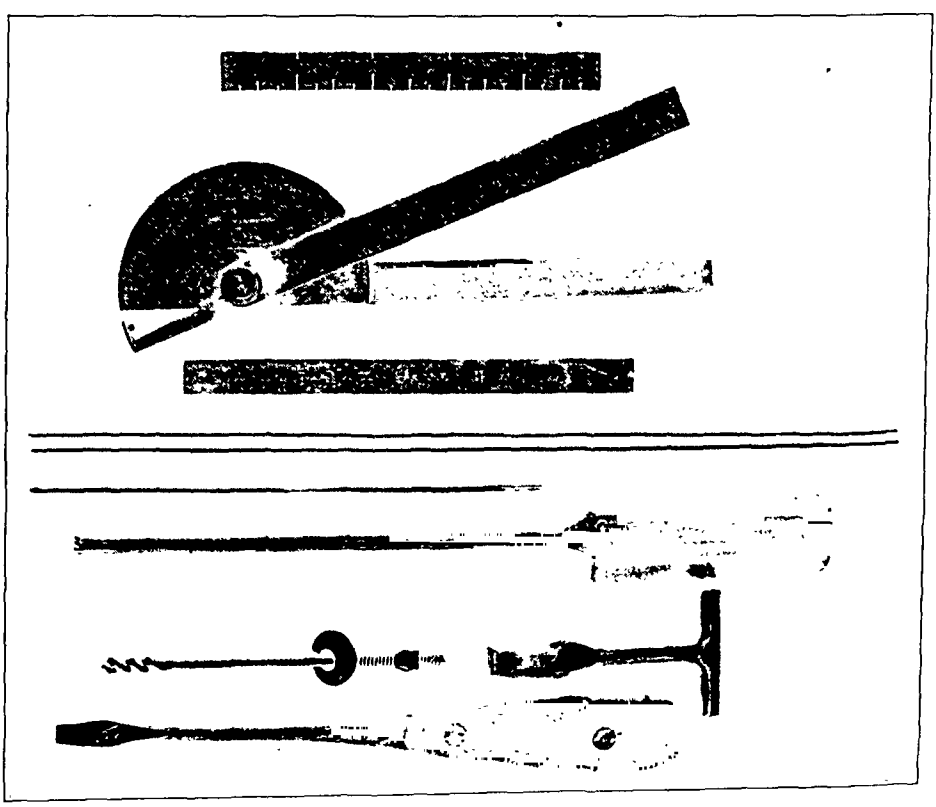


FIG. 1

Special instruments for lateral screw-bolting: (*a*) x-ray marker; (*b*) protractor; (*c*) steel rule; (*d*) Kirschner wires of equal length; (*e*) graduated Watson Jones pin; (*f*) hollow reamer; (*g*) improved screw-bolt and socket wrench; (*h*) screw driver.

* Presented before the British Columbia Medical Society, Vancouver, British Columbia, September 14, 1937.



FIG. 2-B
Fresh intracapsular fracture.

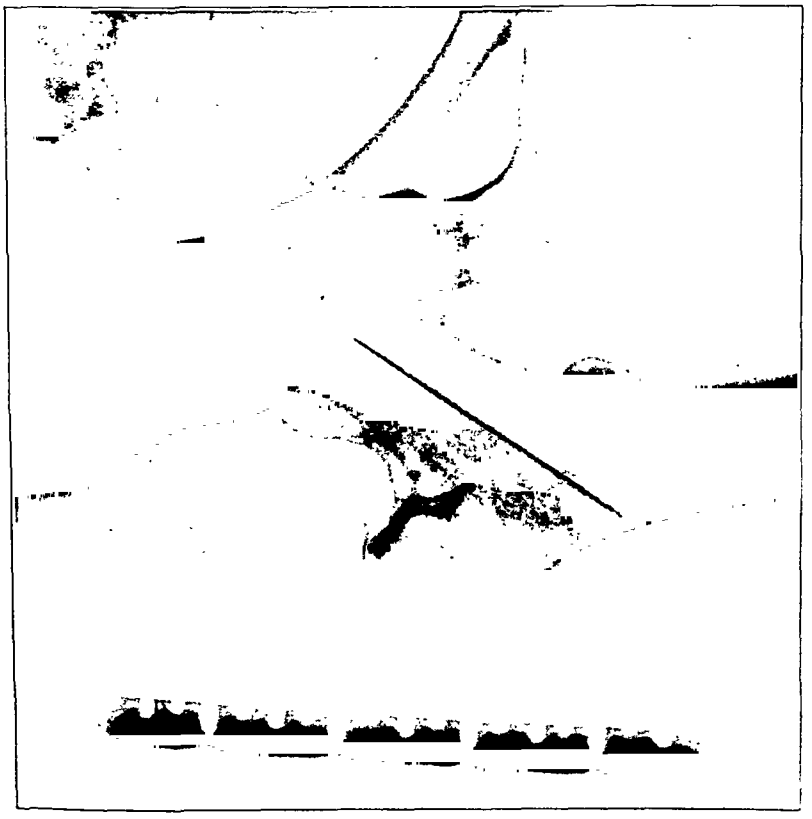


FIG. 2-A
X-ray of sound hip with Schanz marker.



FIG. 3-A

Fresh intracapsular fracture reduced in traction.



FIG. 3-B

Kirschner wire *in situ*.

the hip has appealed to others, and the author has developed a simple method of accurately introducing his rustless-steel screw-bolt through a small lateral incision. Only a few special instruments (Fig. 1) are required. If properly introduced, the screw-bolt does not tend to wander or to slip out, and bony union has been secured with it in spite of partial absorption of the neck. The improved method of lateral introduction is as follows:

The sound hip is x-rayed with a graduated marker (Fig. 2-A) and taped to the skin alongside the trochanter, as advocated by Schanz of Dresden. On such a roentgenogram of the sound hip, the angle of the femoral neck is measured precisely with a protractor. The exact length of the neck shadow, from the optimum point on the trochanteric side to the point of desired penetration into the head, is measured on the film with a steel rule. The exact length of screw-bolt penetration can then be computed * as the real length of the Schanz marker is known.

The fractured hip (Fig. 2-B) is reduced under general or local anaesthesia by the Leadbetter manipulation, and both extremities are put up in traction on the fracture table in moderate abduction (Fig. 3-A). Next a six-inch incision is made distal to the trochanter, and the upper femoral shaft is exposed subperiosteally. Two heavy Kirschner wires of exactly the same length are needed. One wire is introduced carefully with the hand drill at the angle set on the protractor as previously determined from the roentgenogram of the sound side. The exact amount of penetration is measured from time to time during insertion by removing the drill,

* Formula: Shadow of marker (measured on film) is to actual length of marker (known in inches) as shadow of neck (measured on film) is to real length of neck ($x$). The desired penetration is usually three and one-half to four inches.



FIG. 4-A

Hollow reamer following wire (Watson Jones guide pin not used in this case—note slipping of head).

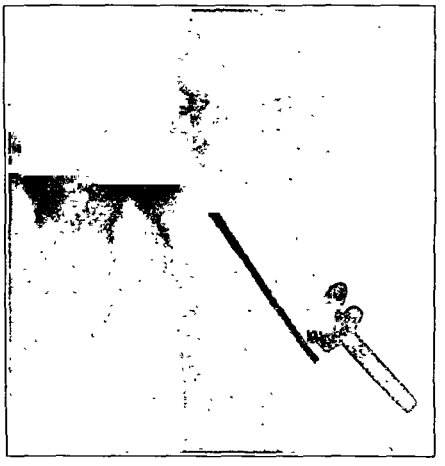


FIG. 4-B

Accessory pin to prevent rotation of head. Screw-bolt in place.

placing the second wire against the bony cortex alongside the first, and measuring the projecting remainder of the second wire over the inserted wire. By proceeding in this way there is no risk of penetrating the joint or the pelvis, and the guide wire can be introduced the exact predetermined distance (Fig. 3-B). Anteroposterior and lateral roentgenograms are made to verify the position of this guide wire; if it has not been precisely placed, the wire is withdrawn and introduced again, and the position verified with x-rays. A Moore pin or an engraved, graduated Watson Jones pin is inserted with a hand chuck alongside the guide wire, so as to engage the head and prevent rotation or displacement of the head temporarily (Figs. 4-A and 4-B). A graduated, hollow hand reamer, which follows the guide wire, but does not cut it, is used to bore a channel from the trochanteric side, so as to just enter the head. This is usually a distance three-quarters of an inch less than the penetration of the wire, and one must not cut too deeply into the head for fear of jeopardizing the firm bite of the whole screw tip in the bone of the head. The reamer and Kirschner-wire guide are withdrawn, and the rustless-steel screw-bolt is screwed into the unreamed head with a screw driver. The Watson Jones guide pin prevents rotation or displacement of the head during this



FIG. 5

End result. Screw-bolt and pin withdrawn.

manoeuver. The femoral head is then drawn tightly back onto the neck by tightening the machine-screw nut against a curved washer on the trochanteric end of the bolt. If the socket wrench is used, one must be careful not to strip the threads. Check-up roentgenograms are again made in two planes before the Watson Jones pin is withdrawn and the wound is closed.

No external fixation is necessary, and early motion of the extremity is encouraged to improve the local circulation. The protruding end of the bolt under the skin keeps the patient from lying on the affected hip during the healing period. Weight-bearing is not permitted for six months, or until roentgenograms reveal good bony union (Fig. 5).

After a thorough trial of weight-bearing, the entire screw-bolt and washer can be removed, if desired, through a small lateral incision under novocain; the screw-bolt is simply unscrewed with a screw driver.

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# CORRECTION OF SCOLIOSIS BY A DISTRACTOR APPARATUS

BY JOHN DONALDSON, M.D., ELIZABETHTOWN, PENNSYLVANIA, AND
O. ANDERSON ENGH, M.D., WASHINGTON, D. C.

*From the State Hospital for Crippled Children, Elizabethtown, Pennsylvania*

The principle of distraction for the correction of scoliosis is not new. The most commonly used method is that with the turnbuckle apparatus. We wish to present our method and to show some of the results. Although it has been tried in only six cases, it has produced a fair correction in each.

Three of the cases were due to infantile paralysis; one was caused by a pyogenic hip; and the remaining two were of unexplained etiology. The six patients ranged from thirteen to seventeen years of age. Three were boys and three were girls. Other forms of treatment had been tried previously without much success. Rotation of vertebrae was observed in the roentgenograms of five of the patients, who also had an accompanying kyphosis.

Our method is to apply a snug, well-molded body cast, with the patient lying on a Hawley table. We use an adjustable stand beneath the prominence, so as to obtain slight hyperextension. No felt is used and only a small amount of sheet wadding is applied over the bony prominences. Assistants maintain slight traction to the head and legs during the application of the plaster. It is important that the bandages are rubbed well, so as to produce a hard, light cast. It should extend high on the chest and low over the pelvis. The distractors are added to each side by simply wrapping a few rolls of plaster around them.

The threaded-tube type of distractor (Fig. 1) which we devised is

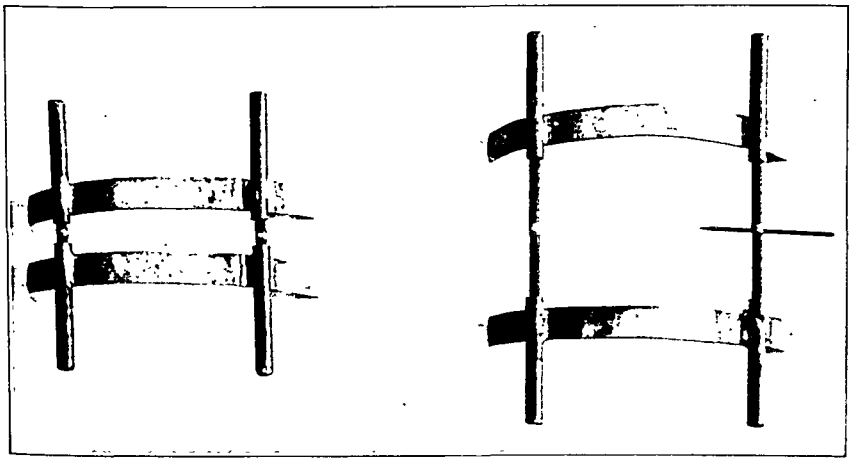


FIG. 1

Threaded-tube type of distractor.

FIG. 2-C

Case 1. M. C., June 6, 1937. Patient supine. There has been an increase in height of ten inches.



FIG. 2-B

Case 1. M. C., January 8, 1937, six months after distractor treatment. Patient supine in body cast with distractors. The pelvis is considerably lower than in Fig. 2-A.



FIG. 2-A

Case 1. M. C., March 6, 1936, before treatment. Patient supine. Note height of pelvis.

FIG. 3-A

Case 2. P. S., December 10, 1935. Clinic roentgenogram. Patient in erect position.



FIG. 3-B

Case 2. P. S., April 29, 1936, one month after distraction was begun. Patient supine in body cast with distractors.



FIG. 3-C

Case 2. P. S., June 3, 1936, on discharge. Patient supine.

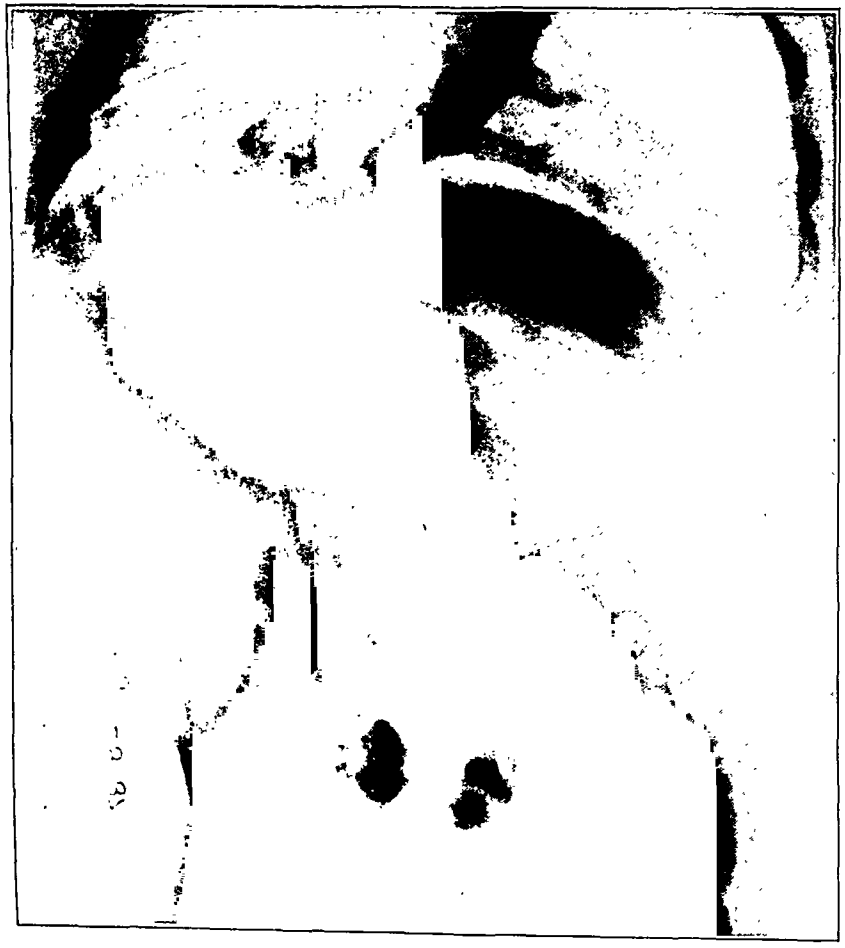


FIG. 4-A

Case 3. W. E., January 28, 1937, on admission. Patient erect. The details are obscure because of the marked deformity. Note the height of the pelvis.

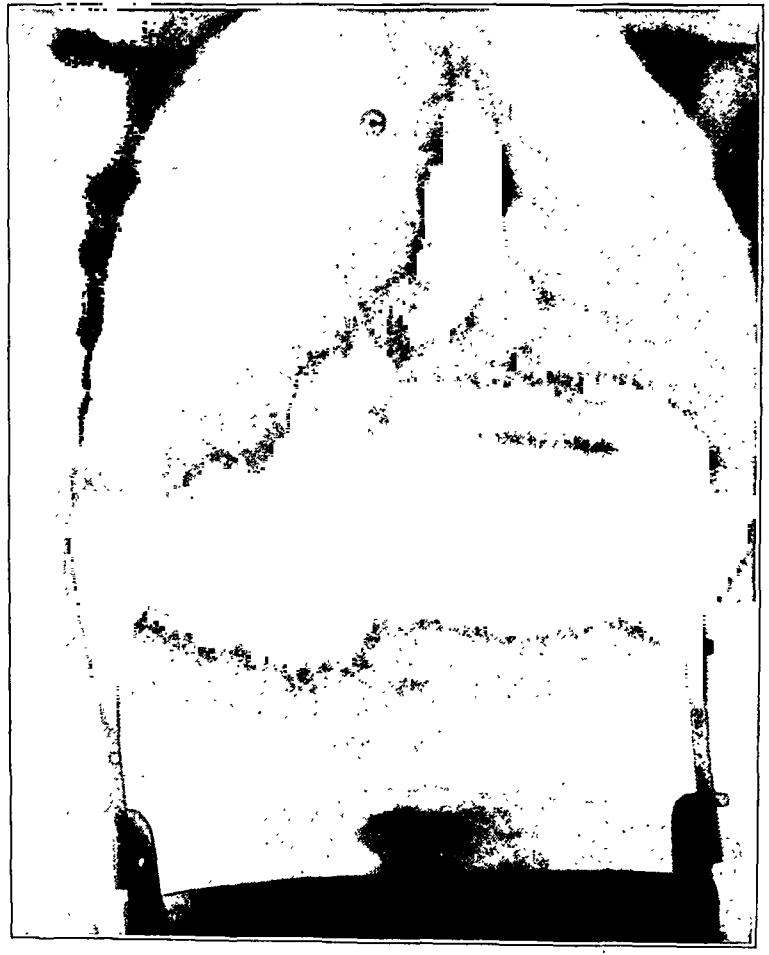


FIG. 4-B

Case 3. W. E., July 2, 1937, three and one-half weeks after treatment. Patient erect. Note that the pelvis is considerably lower than in Fig. 4-A. The patient was ambulant during treatment and there was an increase in height of five inches in four and one-half weeks.

superior to loose turnbuckles or the exposed-thread type, which we formerly used. They can be entirely incorporated in the plaster, making application easy; they are comfortable; and they are not visible under clothing. Four days are required for drying. Then the cast is split horizontally (opposite the apex of the curvature if possible), producing lower and upper portions. Distraction must be slow and gradual. A quarter of a turn daily is sufficient. If the patient complains of "burning", it is best to postpone the distraction for a few days. In one of our cases, in which distraction was rapid, a pressure sore developed. Usually a few days are required before the ascending portion of the cast grasps the upper thorax and the descending portion grasps the pelvis. The circumference of the upper thorax and of the pelvis is greater than of the intervening region, causing the spine to be stretched between them. Each distractor is turned an equal distance. No attempt is made to increase the correction on one side.

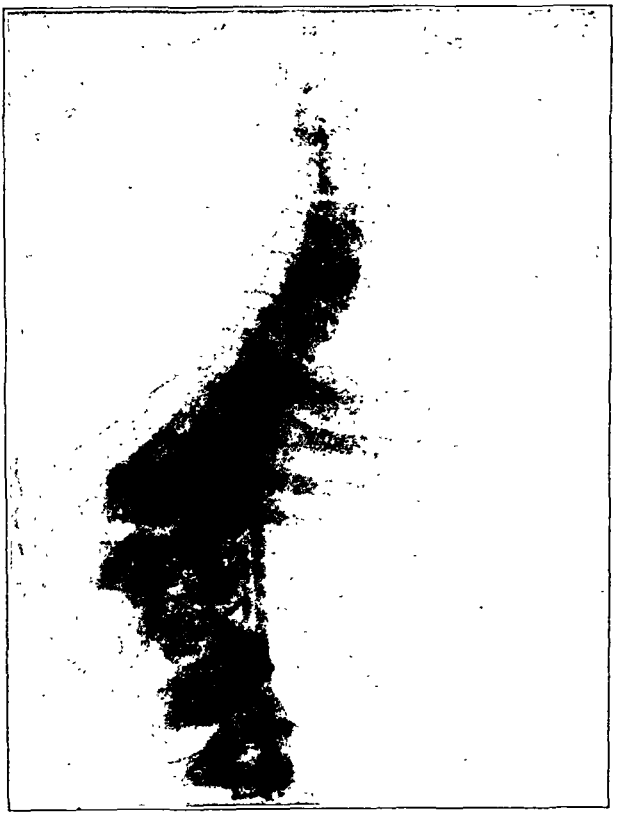


FIG. 4-C

Case 3. W. E., December 6, 1937. Final roentgenogram showing tibial graft. Patient supine. There has been an increase in height of eight inches.



FIG. 4-D

Case 3. W. E., in cast with distractors.

After satisfactory correction has been obtained, a brace may be applied. Sometimes the spread is maintained by wooden wedges and a fusion operation is performed through a window in the back of the cast. In Case 1, we applied three distractor casts, decreasing the curvature each time. However, each case is an individual problem and it is beyond the scope of this paper to discuss the procedure, once satisfactory correction has been obtained.

The patient in Case 1, whose condition was due to destructive hip-joint disease, was made ten inches taller by the apparatus. She was in the hospital for over a year. During this time she also had several operations on the involved leg. This permitted us to proceed gradually. The patients in Cases 2 and 3, in whom the scoliosis was the result of infantile paralysis, were made three and one-half and five inches taller, respectively, after one month's treatment. In Case 3 the patient was ambulant during treatment. The correction in these cases is easily recognized in the roentgenograms. The marked lowering of the pelvis and the decrease in angulation are well demonstrated.

We do not believe that a distractor apparatus should be used in every case of scoliosis. The principle of correction must be borne in mind. Although we obtained good results in all our cases, we were careful to choose the types of patients suited for this procedure. It should not be attempted on an obese individual or on one with poor chest development. It is a good plan to measure the abdomen and upper chest and if the latter is not a few inches greater the procedure should not be attempted.

We have not found it necessary to incorporate the chin and pelvis in the cast as is done by Moore. In all our cases, simple body casts were sufficient. We do not keep all our patients in bed. The fact that in Case 3 an increase in height of five inches was obtained after one month of treatment has encouraged us to try this method in the future whenever feasible. We believe in some instances that it is a good plan to combine or to alternate simple distraction with the methods of Hibbs, Risser, and Ferguson, Galeazzi, and others.

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# TREATMENT OF LOCALIZED FIBROCYSTIC CAVITIES IN BONE BY CURETTAGE AND PACKING WITH BONE CHIPS *

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*From the New York Orthopaedic Dispensary and Hospital*

One of the interesting moments in an orthopaedic surgeon's practice occurs when he examines the roentgenogram of a patient and sees a cavity in the shaft or near the end of one of the bones. Of the lesions which can cause such a cavity, those under discussion in this paper comprise a group which are relatively benign, and yet, if left to their own devices, show a tendency to progressive expansion and absorption of the bone with the production of pain, deformity, and disability. According to present-day pathological conceptions, they seem to belong to the same family which may be called by the surname of localized fibrocystic disease of bone, and they seem to exhibit many similarities of clinical appearance and behavior. On the other hand, they do show marked differences of the actual local pathology, on the basis of which they have been divided into the following three groups for purposes of this study: (1) lesions which are found to be cavities in the shaft of the bone, filled with fluid and surrounded by a limiting fibrous membrane, called bone cysts; (2) lesions which are cavities in the shaft of the bone, filled with firm, cellular, fibrous tissue, described as osteitis fibrosa cystica; and (3) lesions which are cavities at the epiphysis, filled with soft, vascular tissue of characteristic microscopic appearance, diagnosed as giant-cell tumors.

As this paper is concerned with treatment, we shall pass over the interesting questions which arise in a discussion of the etiology and nature of these lesions, and confine ourselves to the way in which they have been treated at the New York Orthopaedic Dispensary and Hospital, and with what results.

The problem of treatment is twofold: how to stop the activity of the disease, for we know it may progress if left alone; and how to set the stage so that orderly repair processes may restore the bone to a healthy state. Although some men have handled this problem by the use of roentgenotherapy and others by surgical curettage and cauterization, reporting more or less satisfactory results, the surgeons at the New York Orthopaedic Hospital have dealt with it surgically by curettage of the cavity, followed by packing it with bone chips without cauterization. The advantages of this approach are several. In the first place, a more exact diagnosis is possible if the lesion is actually seen and tissue from it is studied microscopically. Second, if the diseased tissue is removed as com-

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 20, 1938.



FIG. 1-A
Case 1

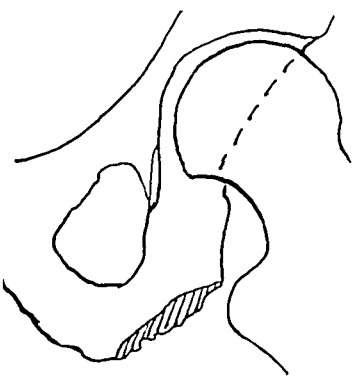


FIG. 1-B
Case 1

restriction of abduction and adduction and of the rotatory movements in one of the cases (Case 7). These symptoms from the hip joint, however, disappeared during the patient's stay at the hospital, and on discharge from the hospital it was not possible in a single case to establish any symptoms of an affection of the hip joint. The roentgenograms of these three cases in which there were symptoms from the hip joint show that the destruction within the ischium reached the acetabulum. (See Figures 3-A, 3-B, 4-A, 4-B, 5-A, 5-B, and 8.) The readiest explanation of the occurrence of symptoms from the hip joint in these cases is, without doubt, that they are due to an irritation from the juxta-articular focus. All three of these patients were operated on. At operation, in Case 3, the destruction of the superior ramus was found to have reached the lower edge of the acetabulum. In

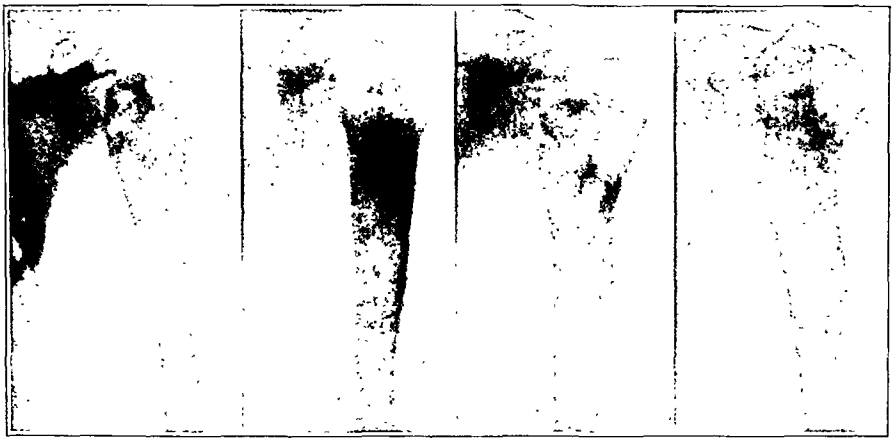


FIG. 2-A FIG. 2-B FIG. 2-C FIG. 2-D

Bone cyst filled with fluid in the upper end of the humerus of a female, eight years old. There were no symptoms until a fracture through the lesion occurred. The fracture united, but the lesion progressed.

Fig. 2-A: Cavity in humerus before curettage and packing with chips.

Fig. 2-B: Five months after operation. The lesion was thought to be healing, but at the end of sixteen months a recurrence was noted.

Fig. 2-C: Three years after operation. The lesion had become larger and at operation it was found to be filled with fluid. The cavity was curetted and packed with chips.

Fig. 2-D: Two years after the second operation. Lesion healed.

definite stimulus to the osteogenic-repair process and that their presence materially hastens the healing of the cavity.



FIG. 3-A FIG. 3-B FIG. 3-C

Osteitis fibrosa in the shaft of the femur of a female, eighteen years old. The symptoms were of seven years' duration. There had been a steady increase in the size of the lesion in spite of three courses of roentgenotherapy.

Fig. 3-A: Cavity in femur before curettage and packing with chips.

Fig. 3-B: Five months after operation.

Fig. 3-C: Eight years after operation. Lesion healed.

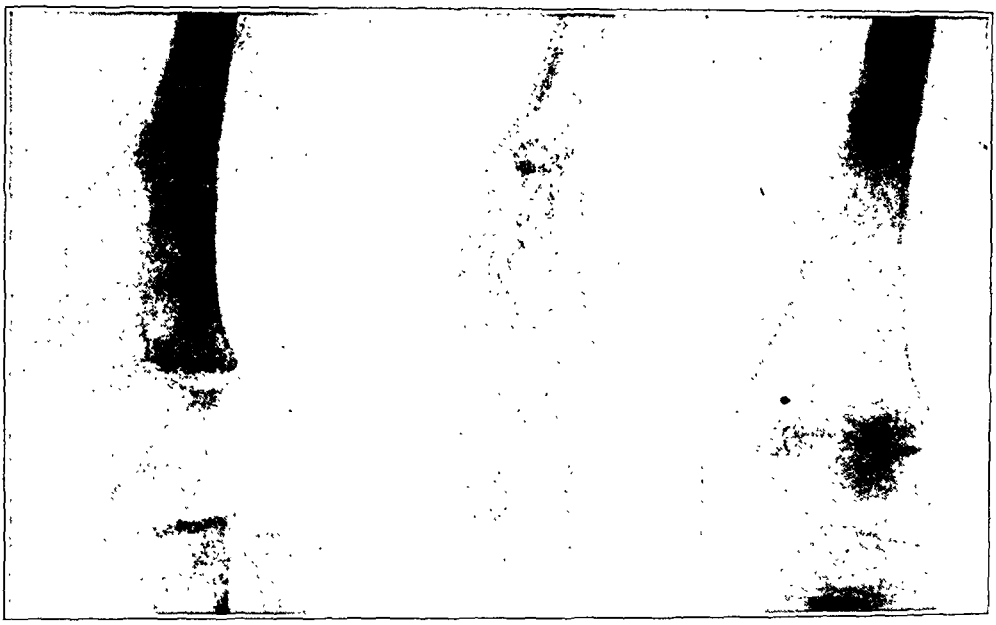


FIG. 1-A FIG. 1-B FIG. 1-C

Bone cyst filled with fluid in the lower end of the femur of a male, three years old. There were no symptoms. Swelling of the knee was noted by the child's mother.
Fig. 1-A: Cavity before curettage and packing with bone chips.
Fig. 1-B: Two months after operation.
Fig. 1-C: Two and one-half years after operation. Lesion healed.

pletely as possible, it would seem that the processes of repair would have the best environment in which to function. Third, if the cavity is filled with small bone chips, a framework for the new, vascular, fibroblastic repair tissue is provided, as well as a concentrated source of calcium and phosphorus salts which will be available at the place where they are needed as soon as local conditions are right for the formation of new bone.

Our conception of the process of repair that occurs in a cavity which has been filled with bone chips may be stated briefly. Blood or serum fills the spaces around the individual chips. As clotting takes place, the fibrin network binds the bone chips together, and the whole area then becomes infiltrated by a rapidly growing, vascular, fibroblastic tissue. The bone chips themselves quickly lose their individual cells and, if examined under the microscope after a few days, will appear like dead bone. However, in spite of this, and as early as the second week, a layer of new bone is formed around and intimately adherent to the outer surface of each chip, while trabeculae of new bone appear in the narrow spaces between the chips. These trabeculae will join the new bone formed around the chips, so that a network of trabeculated bone is developed with the apparently dead chips as integral parts. The old chips may remain and be recognizable for a long time, but they do not seem to act as irritating foreign bodies or sequestra, nor do they appear to encourage the development of giant cells around their margins. Eventually they lose their identity through some process of resorption as the structure of the bone approaches nearer to a healthy state. It is felt that the bone chips add a

*Osteitis Fibrosa*

There were fifteen patients in this group,—eleven females and four males of an average age of twelve years. The femur was involved six times, the tibia and the humerus each three times, and a metatarsal bone, a fibula, and a finger phalanx each once. These fifteen patients required twenty-three operations, as six of them had lesions which recurred after the first operation. One of these lesions, in a tibia, showed great persistence, as it returned three times in the original location and once higher up, so that this individual required five operations before a cure was effected. Another patient had a lesion which recurred after a second operation. One patient had a large cavity in the trochanter and neck of the femur, which had been treated without effect by roentgenotherapy for one and one-half years. This patient was operated upon and seemed to be doing well for ten months, after which time the lesion recurred. This patient and the preceding one have been lost to the Follow-Up Clinic. Another patient has in the humerus a recurrent lesion of much smaller size than the original cavity, and during six years it has shown no tendency to increase, so that its character has probably been altered. A lesion in the upper end of the humerus recurred twice, but has been cured by the third operation. There was one recurrence in the phalanx of a finger, but the lesion has remained healed after the second curettage and packing with bone chips. The final results in this group are shown in Table II. One patient, a child of seven, died of shock soon after the operation which was performed on a hot summer day. The lesion was a large one in the shaft of the

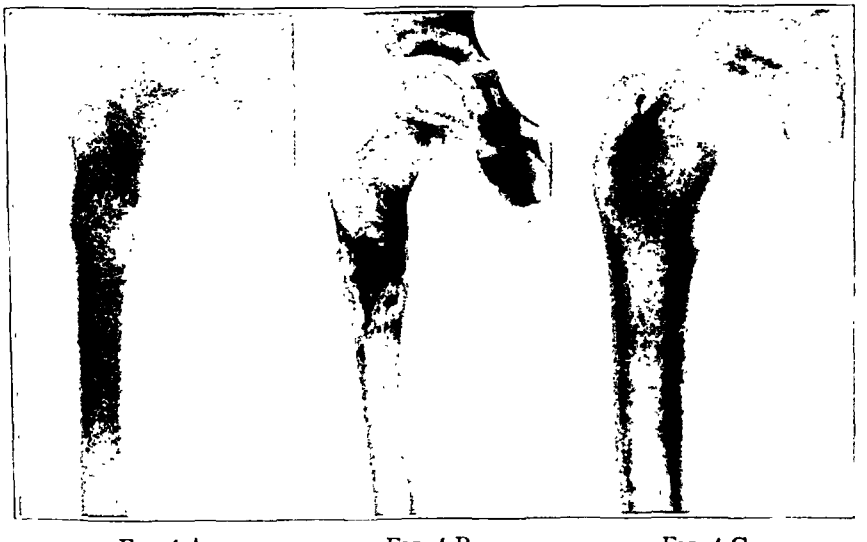


FIG. 4-A FIG. 4-B FIG 4-C

Osteitis fibrosa in the upper part of the shaft of the femur in a male, six years old. Pain and a limp had been present for two months.
Fig. 4-A: Cavity in the shaft of the femur before curettage and packing with chips.
Fig. 4-B: One month after operation.
Fig. 4-C: Seven years after operation. Lesion healed.

TABLE I

ANALYSIS AND RESULTS OF SIX CASES OF BONE CYSTS

| | |
|---|---|
| Number of patients | 6 |
| Average age of patients | 9 years |
| Number of recurrent lesions | 2 (33 per cent.) |
| Number of operations for recurrence: | 2 (2 patients) |
| Curettage and bone chips..... 2 | |
| Average time when recurrence was noted | 15 months |
| Average follow-up period | 3 years |
| Number of lesions healed | 6 (100 per cent.) |
| Number of lesions not healed | 0 |
| Number of deaths | 0 |

That this type of repair is a complicated one, involving many chemical and pathological factors which are not understood, goes without saying, and, therefore, it is to be expected that some lesions may not follow the rule. There are recurrences after curettage and packing with bone chips, and here again it is hard to understand or to explain the factors involved. It is interesting that the actual pathology found in a recurrent lesion is usually similar to that which was seen in the original cavity,—that is, the contents will be made up of either fluid, or fibrous tissue, or giant-cell tumor. It is also interesting that recurrent lesions treated by curettage and packing with bone chips will usually heal satisfactorily, although several operations may be necessary.

The surgeons at the New York Orthopaedic Hospital began in 1922 to treat fibrocystic cavities in bones by thorough curettage and packing with small bone chips usually obtained from the shaft of the tibia. Between 1922 and 1935, twenty-eight patients who presented such lesions were treated in the manner outlined and the cases were classified according to the three groups which have already been mentioned,—bone cysts, osteitis fibrosa, and giant-cell tumors.

*Bone Cysts*

These were six in number and occurred in the youngest age group, the average age being nine years. Four were in males and two in females. The humerus was involved three times and the radius, femur, and fibula each once. Four of the six lesions were recognized after a fracture at their site; one was discovered because of pain; and one was found incidental to an examination for a foot complaint. Eight operations were performed on these six patients, as two lesions recurred, each recurrent lesion being a cyst filled with fluid and without any evidence of bone chips. The results in this group are shown in Table I. Each patient has been well, with roentgenographic evidence of healthy bone repair, for at least one year after operation. The average follow-up period is three years.

TABLE II

ANALYSIS AND RESULTS OF FIFTEEN CASES OF OSTEITIS FIBROSA CYSTICA

| | |
|---|---|
| Number of patients | 15 |
| Average age of patients | 12 years |
| Number of recurrent lesions | 6 (40 per cent.) |
| Number of operations for recurrence: | 8 (4 patients) |
| Curettage and bone chips..... 8 | |
| Number of recurrent lesions not operated upon | 2 |
| Average time when recurrence was noted | 12 months |
| Average follow-up period | 4 years |
| Number of lesions healed | 11 (73 per cent.) |
| Number of lesions not healed | 3 (20 per cent.) |
| Number of deaths (operative) | 1 ( 7 per cent.) |

tion of the radius. Before surgery was used, the patient had had a long course of roentgenotherapy, sufficient to cause considerable necrosis of the lesion but not to effect healing. In two cases, a leg was amputated. In one of these, the lesion was in the os calcis, and for ten months after the curettage the condition seemed to be healing. Then a recurrence was noticed and, in spite of treatment by roentgenotherapy over a period of five months, the lesion continued to increase in size. A second curettage was advised, but declined, and the patient continued with roentgenotherapy until the skin broke down. Four years later the leg was amputated because of persisting sinuses and continuance of the lesion. In the other case, the lesion was in the lower end of the tibia, and the leg was amputated one month after the original curettage because the lesion was suspected of being malignant. Table III shows the results in this group of giant-cell tumors and demonstrates that all the patients have remained well for an average follow-up period of five years.

TABLE III

ANALYSIS AND RESULTS OF SEVEN CASES OF GIANT-CELL TUMOR

| | |
|---|---|
| Number of patients | 7 |
| Average age of patients | 18 years |
| Number of recurrent lesions | 3 (43 per cent.) |
| Number of operations for recurrence: | 5 |
| Curettage and bone chips..... 3 (1 patient) | |
| Amputation..... 2 | |
| Average time when recurrence was noted | 10 months |
| Average follow-up period | 5 years |
| Number of lesions healed | 5 (71 per cent.) |
| Number of lesions not healed (amputation) | 2 (29 per cent.) |
| Number of deaths | 0 |

femur and had been present for at least two years, during which time there had been two fractures through the area without any tendency for the disease to become arrested, although the fractures had united. Eleven of the patients are considered to be entirely healed after a follow-up period averaging four years, and three patients have recurrent lesions.

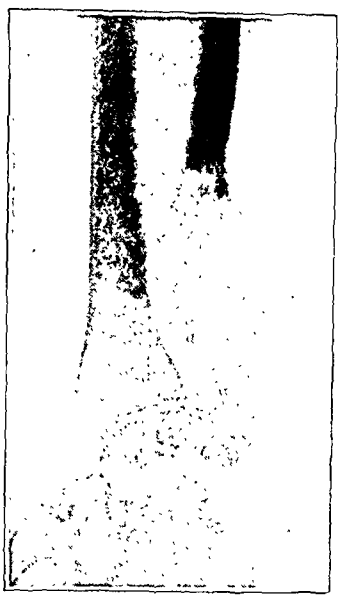


FIG. 5-A

*Giant-Cell Tumors*

Seven patients were included in this group, with an average age at the time of operation of eighteen years. There were five females and two males. The lower end of the tibia was involved in two cases, and in the other five cases the lesions were located in the upper end of the femur, in the upper end of the humerus, in the os calcis, in the lower end of the ulna, and in the pedicle of the third lumbar vertebra. In all, twelve operations were performed on these seven patients. One patient with a lesion in the lower end of the ulna had four operations before a cure was obtained, because the lesion recurred twice in the same site and once in the adjacent por-

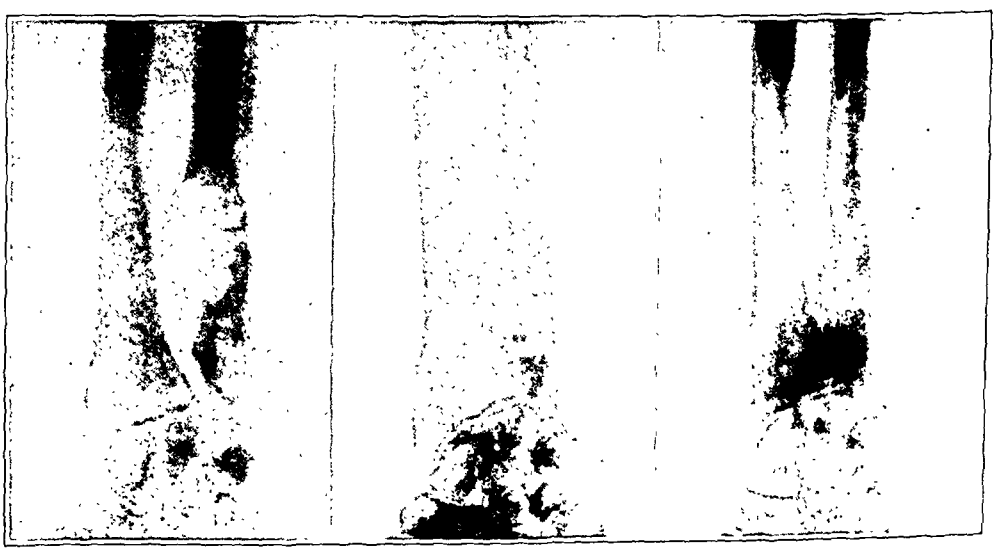


FIG. 5-B FIG. 5-C FIG. 5-D

Giant-cell tumor in the lower end of the ulna of a female, forty-two years old. There had been a steady increase in the size and symptoms for four years in spite of treatment by roentgenotherapy.

Fig. 5-A: Lesion at time of curettage and packing with bone chips.

Fig. 5-B: One year after operation. Recurrent lesion in upper part of original cavity. A second operation, consisting of resection and a bone graft, was performed.

Fig. 5-C: Two years after second operation. Lesion in ulna healed. New area of giant-cell tumor in lower end of radius. This was curetted and packed with bone chips. Recurrence after one year. Lesion again curetted and packed.

Fig. 5-D: One and one-half years after fourth operation. Lesions in ulna and radius are healed.

# SUBCUTANEOUS TENOTOMY OF THE ACHILLES TENDON

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Tenotomy of the Achilles tendon is one of the simplest and most universal procedures in orthopaedic surgery. The surgeon, confronted with the problem of a short heel cord, usually chooses to obtain length by a plastic operation on the tendon or by a subcutaneous tenotomy. The decision depends largely upon the age of the patient, the etiology, and the degree of deformity. Lengthening of the tendon is not sufficient in itself in many instances and must be performed in conjunction with other operative procedures on the foot. The question of the relative value of the open plastic operation and the subcutaneous tenotomy arises.

Both methods are universally described and accepted as good treatment. A number of authors make definite statements as to when and when not to employ subcutaneous tenotomy; others make no comment.

Jones and Lovett warned against subcutaneous tenotomy in spastics and in cases of poliomyelitis. They stated definitely that they preferred the open plastic method. They did, however, utilize the subcutaneous section for the correction of club-foot in infants.

Soutter stated that in large clinics, where thousands of tenotomies had been done, lack of union was almost never seen. He, nevertheless, seemed to favor zig-zag lengthening in preference to transverse section. These are opposing ideas.

Whitman tells us that the open plastic operation is theoretically a safer procedure. He states, further, that subcutaneous tenotomy is preferable when the tendon lengthening is an incident in the treatment of club-foot. These are also opposing statements.

Calot determines his method by the required amount of lengthening. For children, when the necessary correction does not exceed one centimeter, and for adults, when the correction does not exceed two and one-half centimeters, he uses the subcutaneous tenotomy. When the correction required is greater than these figures, he recommends the open plastic method.

Mercer utilizes the closed method for club-foot. He employs both methods for spastics. For the deformity following poliomyelitis, however, he employs only the open plastic method.

Moore described only the technique of subcutaneous tenotomy in lengthening the heel cord in club-foot and in poliomyelitis.

Brockman employs only the subcutaneous tenotomy in club-foot.

Galland, in 1924, discussed the poor results from subcutaneous section. He described a closed plastic lengthening which he much preferred to the simple tenotomy.

TABLE IV

SUMMARY OF TWENTY-EIGHT CASES OF FIBROCYSTIC LESIONS TREATED FROM 1922 TO 1935 *

| Diagnosis | Average Age of Patients (*Years*) | No. of Patients | Lesions Which Recurred | | Total No. of Operations |
|---|---|---|---|---|---|
| | | | *No.* | *Per Cent.* | |
| Bone cyst | 9 | 6 | 2 | 33.0 | 8 |
| Osteitis fibrosa | 12 | 15 | 6 | 40.0 | 23 |
| Giant-cell tumor | 18 | 7 | 3 | 43.0 | 12 |
| Total | | 28 | 11 | 39.0 | 43 |

| Diagnosis | Results | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Lesion Healed | | Lesion Unhealed | | Amputation | | Death | |
| | *Cases* | *Per Cent.* | *Cases* | *Per Cent.* | *Cases* | *Per Cent.* | *Cases* | *Per Cent.* |
| Bone cyst | 6 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Osteitis fibrosa | 11 | 73.0 | 3 | 20.0 | 0 | 0.0 | 1 | 7.0 |
| Giant-cell tumor | 5 | 71.0 | 0 | 0.0 | 2 | 29.0 | 0 | 0.0 |
| Total | 22 | 79.0 | 3 | 11.0 | 2 | 7.0 | 1 | 3.0 |

* 28 patients had 43 operations: 1 patient died of shock; each of 2 patients had a leg amputated; 3 patients have unhealed lesions; 22 patients have healed lesions.

## SUMMARY

The results obtained in the twenty-eight patients of the series are shown in Table IV and reveal several interesting comparisons between the three groups. These lesions have a marked tendency to recur locally, as demonstrated by a 39-per-cent. recurrence in this series. It is important to realize that the average time when the recurrences were noted was as late as one year, so that a long follow-up period is necessary. The local recurrences can be treated successfully in the same way as the original lesions, even though some cases may require several procedures before a cure is obtained. The three patients who still have unhealed lesions are all in the osteitis-fibrosa group, and two of them have been lost to the Follow-Up Clinic without having had the second operation which was advised. In the other case there is an unhealed area which has not increased at all over a period of six years. It is so small that further treatment has not been advised.

Although 79 per cent. of the lesions have healed satisfactorily, the variations in the percentage of success among the three groups must be noted. Because of the similarities which have been observed in the behavior of these lesions under treatment, it is believed that curettage and packing with bone chips is an effective method of dealing with them, and that, as larger numbers are accumulated, the percentage result in each group will tend to be more satisfactory.

Case 5 the focus reached to within three millimeters and in Case 7 to within scarcely one centimeter of the articular capsule. However, similar juxta-articular foci both of a tuberculous and of an unspecific nature were present in two other cases (Cases 8 and 13) without there having occurred any subjective or objective symptoms from the hip joint, and at operation in each case it was possible to establish that the destruction had reached the acetabulum. On the other hand, pronounced symptoms from the hip joint, together with considerable restriction of mobility, occurred in one case (Case 9) of certain septic origin, in which the changes were principally localized to the tuber ischii (Fig. 8). It is difficult to explain the occurrence of symptoms from the hip joint in some cases, while in others the patients remain free from symptoms under circumstances in other respects quite similar. Quite a number of reasons can be thought of as being of importance in this connection, such as the difference in virulence of the bacteria, less resistance to the infection in some patients than in others, etc. Odelberg, who described four cases of osteitis of the ischium of uncertain origin, stated that in one case the mobility of the hip joint on the affected side was restricted. In this case also the symptoms abated completely. It seems to be quite certain that those symptoms from the hip joint which occur in osteitis of the ischium do not signify the setting in of a fully developed coxitis. The information received from the patients goes to prove the same thing.

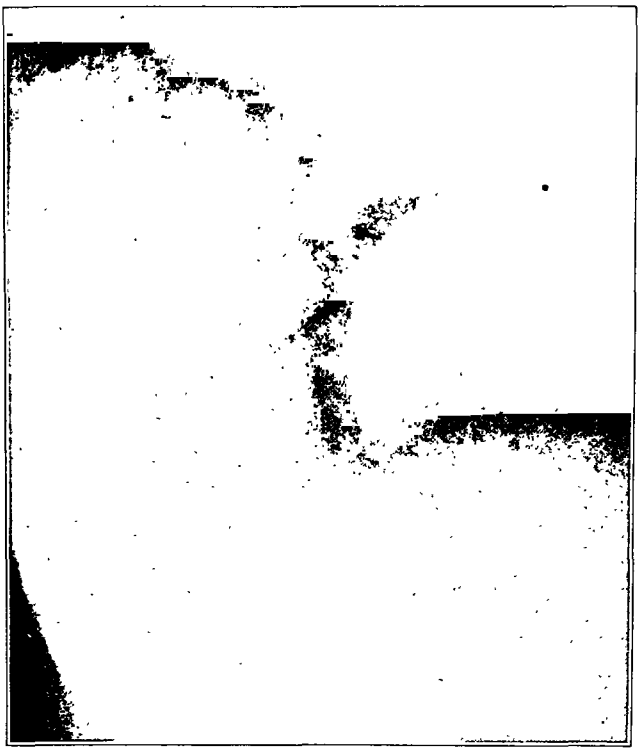


FIG. 2-A
Case 2

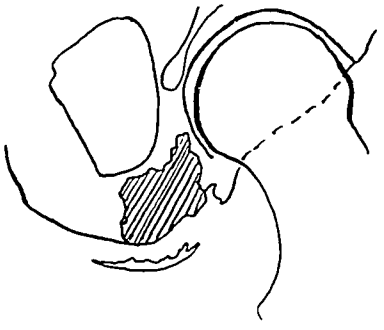


FIG. 2-B
Case 2

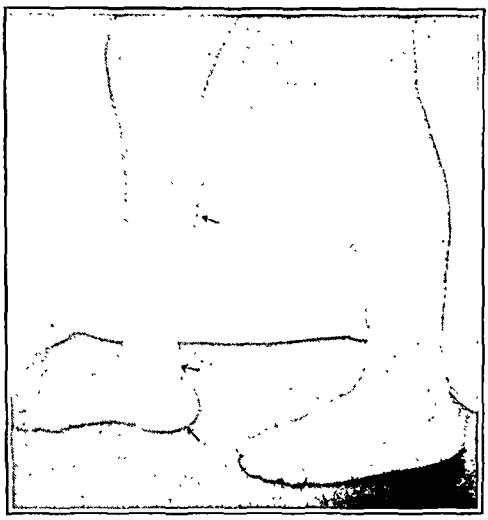


FIG. 1

After subcutaneous tenotomy. Note the atrophied gastrocnemius, the threadlike heel cord, and pes cavus.

It would seem from these authors that plastic lengthening is the preferable method of procedure, but, despite the definite statements of some, the surgeon is left to make his own decision, largely from his own experience. There is no doubt that in the vast majority of subcutaneous tenotomies performed on the heel cord firm union results. However, not infrequently come to our attention patients whose functional results are not of the best. These unfortunate patients present an atrophied gastrocnemius, a threadlike heel cord, and a pes cavus. (See Figure 1.)

The development of this deformity is fairly clear. Behind the external malleolus the peronei run posterior to the transverse axis both of the ankle and of the midtarsal joints. They, therefore, act as flexors. The posterior tibial tendon runs in like manner behind the medial malleolus, and also acts as a flexor to the ankle and midtarsal joints. (See Figure 2.)

Normally, these muscles act synchronously with the gastrocnemius, the soleus, and the plantaris. The Achilles tendon, partially or wholly ununited, either does not act in its normal capacity or fails to function. The body of the os calcis, then, is not acted upon directly in plantar flexion. In an attempt at plantar flexion, midtarsal flexion occurs first by the action of the peronei and tibialis posterior plus the long toe flexors (Fig. 2). When the forefoot is thus flexed, there follows slight excursion of the os calcis (Fig. 3). This action decreases the distance between the origin and insertion of the short toe flexors and plantar fascia, gradually deepening the longitudinal arch (Fig. 4).

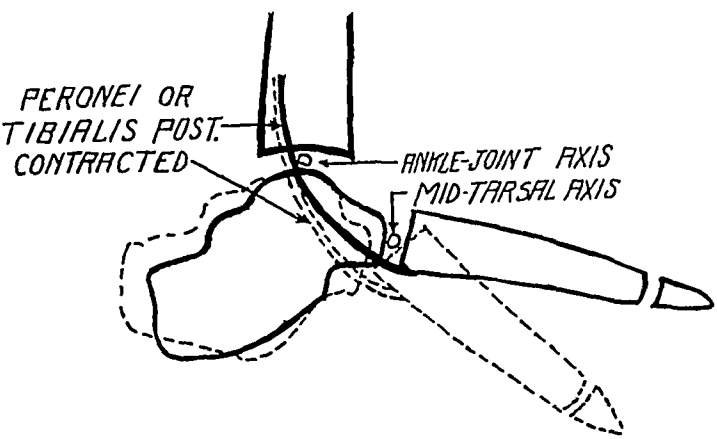



FIG. 2

Diagrammatic drawing, illustrating the development of the deformity shown in Fig. 1.

This Clinic has used both methods of lengthening the Achilles tendon. Our attention was sharply called to seven cases operated upon within a four-year period. Because these cases demonstrated the deformity just described, a serious doubt arose as to the virtue of the closed operation.

Five children were operated upon for club-foot; in one case the deformity was bilateral. The ages of the patients were four weeks, three months, seven months, nine months, and twenty-four months. Two children —one a case of spastic hemiplegia, and the other a case of residual poliomyelitis— were operated upon at seventeen months.

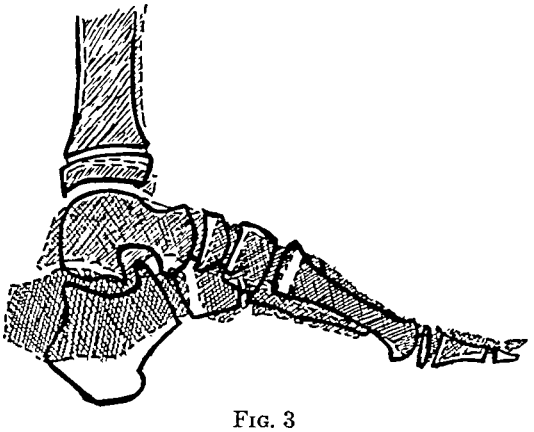


FIG. 3

Drawing showing slight excursion of the os calcis when the forefoot is flexed.

A study of the cases revealed no unusual facts. All underwent the subcutaneous tenotomy. Each patient was placed in a plaster-of-Paris cast from the toes to the groin. The knee was held in 90 degrees of flexion and the foot in from 90 to 100 degrees of dorsiflexion for a period of from six to eight weeks. This method of treatment in general corresponded to that used in other clinics.

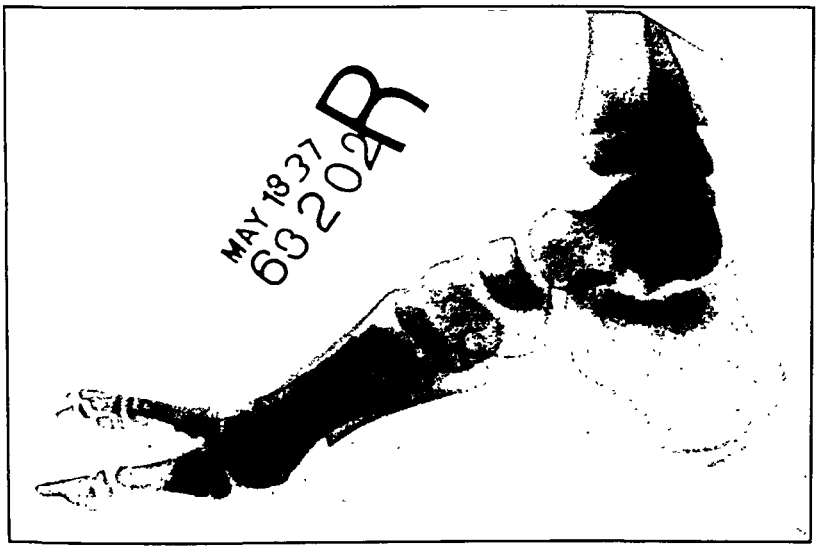



FIG. 4

Roentgenogram showing the deepening of the longitudinal arch as the result of the conditions illustrated in Figs. 2 and 3.

A review of the texts and literature did not add much to our knowledge, nor did it give us more definite criteria to guide us in choosing the type of operation. We, therefore, sent out a number of questionnaires to general surgeons and orthopaedic surgeons, asking for their views on this subject. The enthusiasm, the promptness of the replies, and the definite

## TABLE I

### Summary of Opinions in Regard to Subcutaneous Tenotomy of the Achilles Tendon

| Name | For | Against | Questionable * | Remarks |
|---|---|---|---|---|
| LeRoy C. Abbott<br>San Francisco, California | | X | | Tenotomy has not been done for many years. |
| Carl E. Badgley<br>Ann Arbor, Michigan | | X | | Tenotomy has not been done for many years. |
| George E. Bennett<br>Baltimore, Maryland | X | | | Utilized only in very small children. |
| Willis C. Campbell<br>Memphis, Tennessee | | | X | Utilized in club-foot in infants. |
| Fremont A. Chandler<br>Chicago, Illinois | | X | | Never employ tenotomy. |
| Edward L. Compere<br>Chicago, Illinois | | | X | Open operation preferred. |
| Frank E. Curtis<br>Detroit, Michigan | | X | | Never used this procedure. |
| Vernon L. Hart<br>Minneapolis, Minnesota | | X | | Should not be done if function is expected. |
| Melvin S. Henderson<br>Rochester, Minnesota | | X | | Open operation preferred. |
| Michael Hoke<br>Atlanta, Georgia. | | | X | Only employed in infants. |
| R. Watson Jones<br>Liverpool, England | | | X | Tenotomy rarely indicated. |
| Frederick C. Kidner<br>Detroit, Michigan | | X | | Tenotomy has not been done for twenty years. |
| Don King<br>San Francisco, California | | X | | Tenotomy never done. |
| Samuel Kleinberg<br>New York, N. Y. | X | | | Achillotomy, only a small part of procedure. |
| A. D. LaFerté<br>Detroit, Michigan | | | X | Employed only in club-foot in infants. |
| Arthur T. Legg<br>Boston, Massachusetts | | X | | Tenotomy is never done. |
| Paul B. Magnuson<br>Chicago, Illinois | X | | | Has never had a case in which healing failed to take place. |
| Beveridge H. Moore<br>Chicago, Illinois | | X | | Not been utilized for years. |
| Frank R. Ober<br>Boston, Massachusetts | | X | | Not been used for years. |
| Charles W. Peabody<br>Detroit, Michigan | | X | | Procedure is physiologically unsound. |
| Dallas B. Phemister<br>Chicago, Illinois | X | | | Has not seen atrophy in small children. |
| Edwin W. Ryerson<br>Chicago, Illinois | | | X | Tenotomy only utilized as last resort. |
| Arthur Steindler<br>Iowa City, Iowa | | X | | Tenotomy has practically been given up. |
| Philip D. Wilson<br>New York, N. Y. | | X | | Never sever tendon. Staggered hemisection. |
| Paul C. Williams<br>Dallas, Texas | | X | | Never employed tenotomy. |

* This classification is purely arbitrary and is the authors' reaction to statements made in the letters received.

opinions expressed denoted unusual interest. Table I is a summary of the current feeling in regard to subcutaneous tenotomy.

## COMMENT

This Clinic has abandoned subcutaneous tenotomy of the Achilles tendon because of poor function obtained in seven cases. Stretching of the Achilles tendon with the application of a plaster-of-Paris cast and bone surgery on the feet are more satisfactory in the end.

Our own interpretation of the communications which we have received is that the majority of surgeons hold subcutaneous tenotomy of the Achilles tendon as an unfavorable surgical procedure which must give way to more physiologically sound methods.

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# NON-UNION OF FRACTURES OF THE CARPAL NAVICULAR

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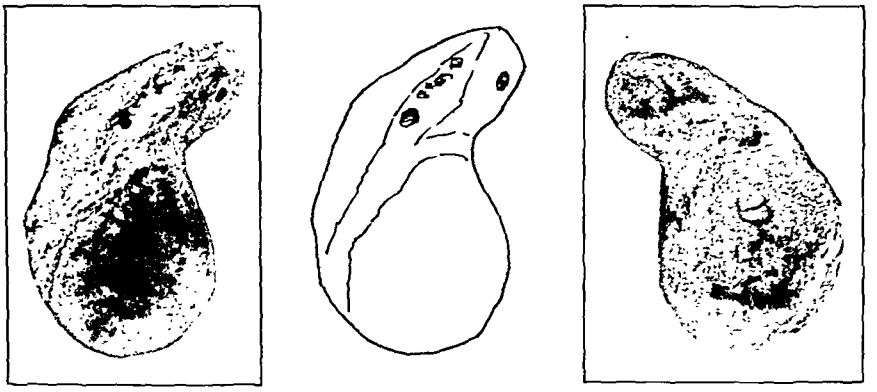
*From the Department of Orthopaedic Surgery, * State University of Iowa*

The tendency of fractures of the carpal navicular to result in non-union has come to be recognized as a distinct characteristic of this fracture which is one of the most serious and disabling traumatic affections of the wrist. Most authorities cite inadequate fixation of the wrist as the chief cause of non-union. They also prefer plaster of-Paris splints or casts as the means of fixation. There is no such unanimity of opinion concerning the position of the wrist during the period of immobilization. However, since equally good results have been reported by surgeons who favor different positions,[2, 3, 9, 10] it is reasonable to assume that the position of the wrist during immobilization is not of primary importance. The period of fixation also varies, being given at from six weeks to six months by various authors.[4, 7, 8, 12] Studies of the healing processes in experimentally produced fractures of the carpal navicular in dogs [5] have shown that bones of the cancellous type heal more slowly than the long bones. This is due largely to lack of subperiosteal callus formation, but it is also due in part to the fact that the cancellous reaction is less extensive and active than the medullary response in the diaphysis. Experience shows, however, that other bones of this cancellous type, such as the bones of the tarsus, heal without delay after fracture or osteotomy. It has also been found experimentally [5] that there is no lytic action of the synovial fluid and, therefore, this cannot be considered responsible for non-union. Studies of the blood supply of the carpal navicular by injection of the arteries with opaque media [6, 8] have shown variations in the positions of the vessels, giving rise to the belief that these variations are important factors in the union of fractured naviculars.

The authors carefully examined 297 carpal naviculars which had been removed from cadavera in the Department of Anatomy of the State University of Iowa. The navicular, freed of its soft-tissue attachments, is found to be almost entirely smooth. Most of its surface consists of articular cartilage, for it articulates with five bones,—the radius, the lunate, the greater multangular, the lesser multangular, and the capitate. There is a narrow rough ridge running obliquely around the dorsal surface from the tuberosity on the lateral side to the proximal base medially. In this ridge are found the arterial foramina, and it is through these apertures that the bone receives its blood supply.

In most of the bones examined it was found that the largest foramina were situated in the distal half of the bone, particularly near the tuberosity. In 13 per cent. of the bones there were no arterial foramina proximal

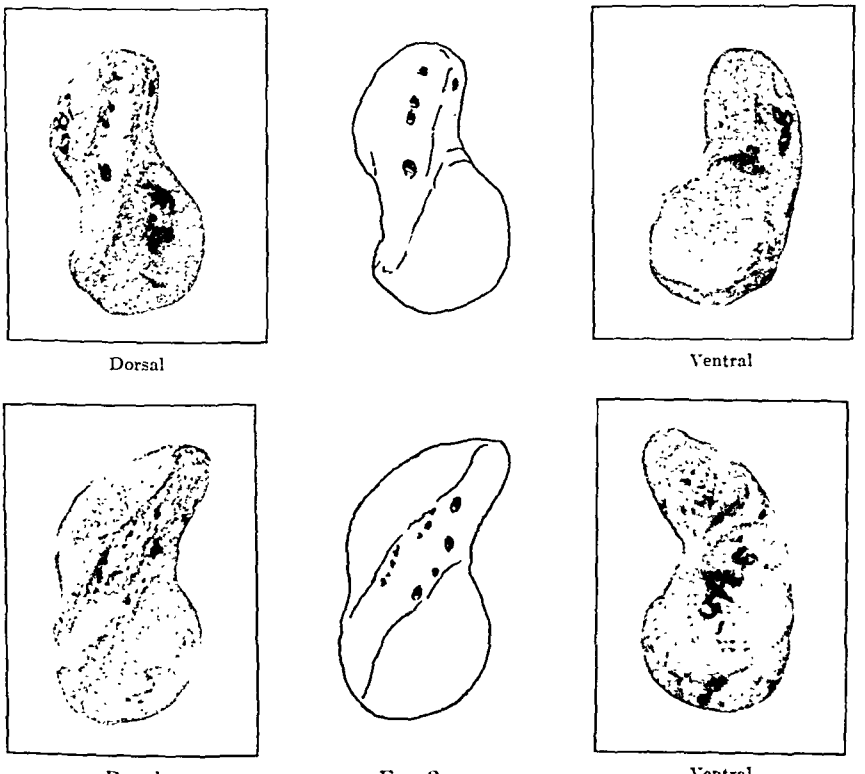
* Service of Arthur Steindler, M.D.



Dorsal FIG. 1 Ventral

Type of navicular showing no arterial foramina proximal to the mid-portion or "waist" of the bone, at which point fracture is most likely to occur. The proximal fragment is totally devoid of blood supply in case of fracture.

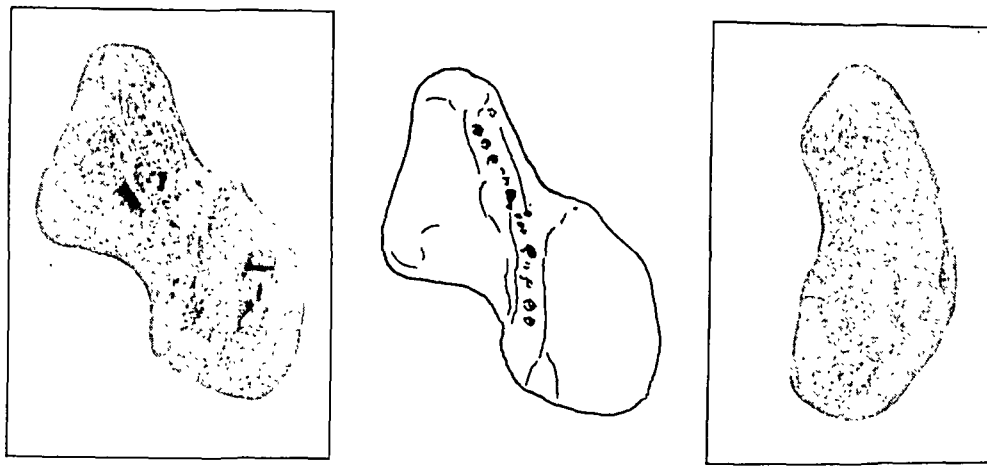
to the constricted mid-portion or "waist" of the bone. (See Figure 1.) In 20 per cent. of the bones examined there was a single small arterial foramen at the waist or proximal to it. (See Figure 2.) In 67 per cent.



Dorsal Ventral

Dorsal FIG. 2 Ventral

Types of navicular showing one arterial foramen at or proximal to the mid-portion. The nutrition of the proximal fragment is probably inadequate where fracture occurs through the mid-portion of the bone.



Dorsal FIG. 3 Ventral

Type of navicular showing two or more arterial foramina proximal to the "waist" of the bone. The nutrition of the proximal fragment is probably adequate if fracture occurs.

there were two or more foramina proximal to the waist. (See Figure 3.) These findings are significant, for most of the fractures of the navicular occur through the waist of the bone. Such fractures would completely interrupt the blood supply to the proximal portion of the bone in at least 13 per cent. of the cases, and would definitely interfere with proper nutrition of the proximal fragment in another 20 per cent. Therefore, in one-third of the instances in which the navicular is fractured through the mid-portion the blood supply is diminished to such an extent that necrosis may occur, and non-union can then be expected. However, if the immobilization is absolute and prolonged for a sufficient period, the necrotic portion will be revitalized by the formation of new blood channels, and union of the fragments can then occur.

Thirty cases of non-union of the carpal navicular were studied. All the patients were men in the most active period of life,—from eighteen to forty-eight years of age. They came to the Clinic on an average of fifteen months after the fractures had occurred. In seventeen cases the fractures had not been recognized, and the wrists had received no immobi-

TABLE I

CLINICAL EXAMINATION

| Findings | No. of Cases | Per Cent. |
|---|---|---|
| Pain in wrist | 30 | 100 |
| Limited flexion and extension | 21 | 70 |
| Swelling | 14 | 47 |
| Weakness of grip | 11 | 37 |
| Tenderness in snuffbox | 11 | 37 |
| Diffuse tenderness | 11 | 37 |
| Arthritic changes | 3 | 10 |
| Associated carpal injuries | 4 | 13 |

TABLE II

ROENTGENOGRAPHIC EXAMINATION

| Findings | No. of Cases | Per Cent. |
|---|---|---|
| Simple fracture line through mid-portion | 10 | 33 |
| Comminution | 2 | 7 |
| Cyst formation | 6 | 20 |
| Necrosis: | 3 | 10 |
| Proximal fragment 2 | | |
| Both fragments 1 | | |
| Osteo-arthritis | 3 | 10 |

lization treatment after the injury. In all of the other cases the immobilization was woefully inadequate, both as to the type of fixation used (slings, adhesive strapping, wood, metal, or plaster-of-Paris splints, etc.) and as to the duration of the period of fixation.

The clinical and roentgenographic findings at the time of the first examination in the Clinic are recorded in Tables I and II.

Only twenty-one of the thirty patients remained for treatment. In seven cases conservative treatment, consisting of immobilization in a cock-up splint or cast of plaster-of-Paris, was instituted. Operative treatment was used in fourteen cases. Excision of one or more fragments was the operation of choice prior to the introduction of the drilling operation by Beck in 1929. The excision completely alters the architecture of the wrist to such an extent that it is indicated now only as a final means of removing the source of pain in comminuted fractures. The drilling operation is much simpler and far less mutilating. Table III shows the end results obtained by the two types of treatment.

## SUMMARY AND CONCLUSIONS

The necessity for prolonged immobilization of the wrist in fractures of the carpal navicular in order to prevent non-union is due to the anatomical variations in the blood supply to the bone. In 13 per cent. of 297 carpal naviculars studied grossly there were no arterial foramina proximal to the

TABLE III

END RESULTS

| Treatment | Total Cases | Cases Improved | Cases Not Improved | Cases Not Followed Up |
|---|---|---|---|---|
| Conservative | 7 | 1 | 2 | 4 |
| Operative: | 14 | 9 | 2 | 3 |
| Partial excision | 4 | 4 | 0 | 0 |
| Complete excision | 6 | 1 | 2 | 3 |
| Drilling | 4 | 4 | 0 | 0 |

mid-portion of the bone, the commonest site of fracture. In 20 per cent. there was one arterial foramen proximal to the waist, while in 67 per cent. two or more foramina were found. Fracture through the mid-portion of the bone could, therefore, interrupt the blood supply in about one-third of the cases and lead to necrosis. Unless immobilization is absolute and prolonged, non-union is liable to develop in these cases.

Conservative surgery (Beck's drilling), followed by adequate immobilization, is the treatment of choice for non-united fractures of the carpal navicular. It is less mutilating than either partial or complete excision of the navicular and results in bony union without alteration of the normal architecture of the wrist.

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# TENSILE STRENGTH OF THE ANTERIOR LONGITUDINAL LIGAMENT IN RELATION TO TREATMENT OF 132 CRUSH FRACTURES OF THE SPINE *

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In a previous paper, submitted for membership in the American Orthopaedic Association in 1927 and published in abbreviated form in 1929, the author stated that the anterior longitudinal ligament could be depended upon to remain intact during the period of stress necessary to reduce a crush fracture of a vertebra by hyperextension. Grounds for this claim consisted of evidence from cadaver dissections and the actual use of hyperextension in a series of thirteen consecutive cases.

Various types of hyperextension have since been developed. Hundreds, probably thousands, of fractures of the spine have been reduced by hyperextension during the past ten years. So far, evidence of damage from hyperextension is not forthcoming. Nevertheless, the fear of overhyperextension still possesses a number of capable and informed operators. Since all crush fractures—whether cervical, thoracic, or lumbar—with or without dislocation or neurological signs depend primarily upon the anterior longitudinal ligament for their reduction, since regardless of which of the number of eligible techniques is employed the use of the anterior common ligament is inescapable, and since fear, caution, and ignorance of the anatomical structures involved have led to distorted quotation of method and are now affecting the literature on the spine, it is imperative to know definitely what sort of use or abuse the main reducing factor, the anterior longitudinal ligament, can withstand.

This paper is based on the end results of 132 cases of fracture of the vertebral centrum seen during the past thirteen years. With but few exceptions, the foot-suspension method was used in all thoracolumbar cases. In all cases the anterior longitudinal ligament was regarded as the check to any possibility of overhyperextension. Misapprehension concerning the mechanics and anatomy involved have apparently led to unwarranted fears sufficient to interfere seriously with adequate reduction. It is, therefore, a matter of fundamental importance to know, if possible, the actual resistance of the ligament to imposed strain versus the amount of stress necessary to obtain reduction.

The difference between the minimal rupture point of the ligament and the maximal pull in pounds necessary to reduction will show the resulting safety factor. The other factor which it is important to know is the degree of elasticity. Since elastic yield would probably involve cord and root damage, it is important to record the actual elongation per unit of imposed strain.

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

The following is offered as evidence of the adequacy of the anterior longitudinal ligament to withstand with a large margin of safety the stress of hyperextension necessary to the reduction of crush fractures. The accompanying record also shows that the anterior longitudinal ligament is a practically non-elastic membrane, resembling, in its behavior under strain, the curve for the reaction of metals.

## METHOD OF MAKING THE TEST

Coronal sections of the spine, including the anterior half of the centra of seven vertebrae in the region of the thoracolumbar junction, were removed from autopsy subjects as they became available. Sufficient bone and disc were removed to permit attachment to specially devised tapered, ringed, metal rods of an instrument known as a "Universal Testing Machine" in the General Electric Test Laboratory, Erie, Penn-

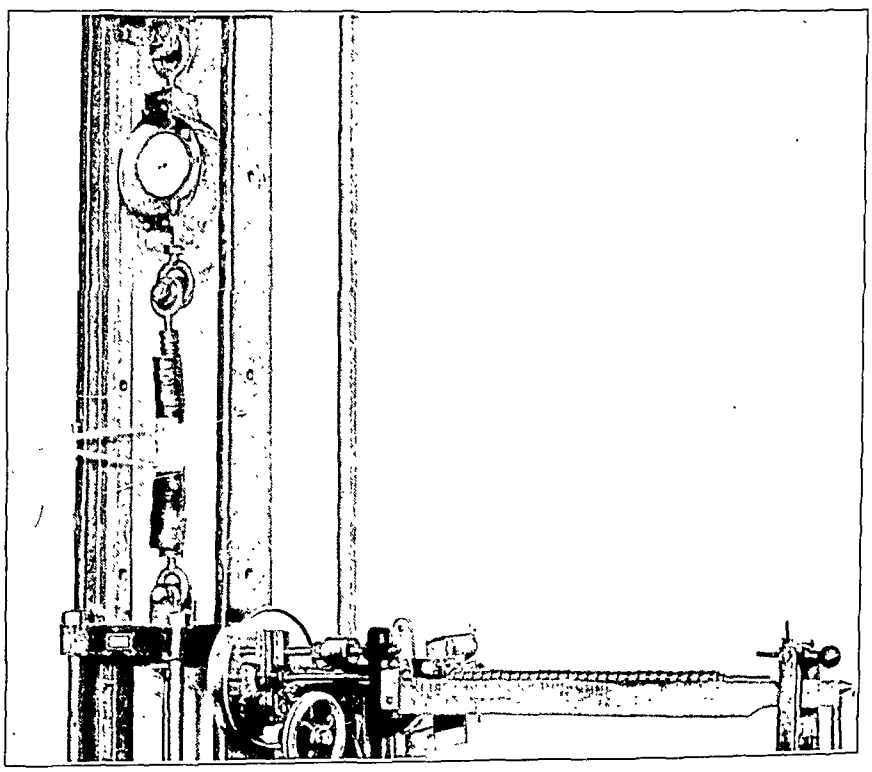


FIG. 1

Seven-vertebrae section mounted on "Universal Testing Machine". Calipers indicate dots used to determine stretch. (*Courtesy of General Electric Test Laboratory.*)

sylvania. (See Figure 1.) The remaining cortical shell, anterior longitudinal ligament, and intervening annulus fibrosus of the specimen were then lashed securely at both ends to the gearlike rods. Considerable difficulty was experienced in preventing the spine from slipping on the rods. By binding them tightly with successive windings of heavy cord, it was possible to give the sharp-edged rings or gears a firm bite into the remaining bony shell, thus preventing the attachments from slipping. The

cord windings were then covered with black tape. The rods were united with a telescoping rod introduced between the traction rods to maintain a vertical pull. No frictional resistance was introduced by the telescoping rod; therefore, no allowance is necessary for this factor. The section of spine remaining for test consisted of one vertebra and two discs.

Elasticity was determined by marking the specimen with India-ink dots two inches apart. Calipers recorded the spread of the marks at intervals of fifty pounds.

The testing of the first two specimens was unavoidably delayed for three days, during which time the specimens were kept immersed in salt solution and formaldehyde. Allowance must, therefore, be made for deterioration. The remaining five specimens were tested within from six to eight hours of removal.

## RESULTS OF TEST

Table I shows the record of seven specimens tested as described. The average breaking point was 337 pounds. Two unusually strong specimens (C. H. and F. J.) are included. Two specimens (V. B. and J. G.) deteriorated; these subjects had been bedridden with longstanding illness. No specimens from females as yet have become available.

TABLE I

RESULTS OF TESTS OF ANTERIOR LONGITUDINAL LIGAMENT

| Case | Age (*Years*) | Occupation | Illness | Duration of Illness | Yield in Two-Inch Section | Breaking Point (*Pounds*) |
|---|---|---|---|---|---|---|
| V. B..... | 44 | Molder | Occupational emphysema | 5 years | .012 of an inch in 150 pounds | 180 |
| J. G..... | 65 | Unknown | Carcinoma of stomach | 2 years | | 160 |
| R. B..... | 54 | Lumberman | Bone sarcoma | 6 months | .08 of an inch in 200 pounds | 230 |
| H. W..... | 83 | Unknown | Fracture at base of skull with cerebral hemorrhage | 1 day | | 360 |
| C. H..... | 17 | Athlete | Septicaemia | 1 week | .02 of an inch in 200 pounds | 550 |
| F. J..... | 27 | Molder | Perforated duodenal ulcer | 1 month | | 480 |
| I. B..... | 42 | Machinist | Endocarditis | A few hours | | 400 |
| Average... | 47 5 | | | | .037 of an inch per 50 pounds over 150 | 337* |

* The average breaking point, excluding the two delayed specimens, was 404 pounds.



FIG. 3-A
Case 3. Before operation.

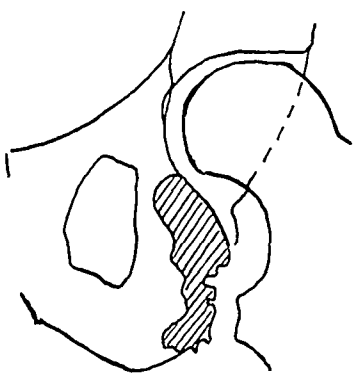


FIG. 3-B
Case 3. Before operation.

Unfortunately, it was impossible to carry out a personal follow-up examination of the patients, as they live in widely different parts of the country. Instead, they were asked to answer a set of questions. Of the eight patients with certain tuberculous osteitis of the ischium, seven replied to the questionnaires. All seven of these patients stated that both of their hip joints were equally mobile. It is true that lesser degrees of restricted mobility may have been overlooked, but this is hardly probable as even very small restrictions of mobility as a rule cause discomfort. The longest period of observation was eight years; the shortest, one year. Of the five patients with an osteitis of unspecific or uncertain origin, four sent in answers to the questionnaires. These patients have also been free from symptoms from the hip joint since their discharge from the hospital.

As none of these patients were brought under observation until they had reached a comparatively late stage of the disease, there are no roentgenograms of the earlier stages. This also seems to be the case in previously published cases of tuberculous osteitis of the ischium. Thus it is possible to give only an account of the roentgenograms of the later stages of the disease. Both the tuberculous and the unspecific forms of osteitis are characterized by wide-spread destruction, in some cases with abundant formation of sequestra. In all of these cases, as well as in previously published cases [1,4,5] of both tuberculous and unspecific osteitis, the destruction was localized to the *lateral part of the superior ramus* or the *lower part of the tuber ischii*. In two of the

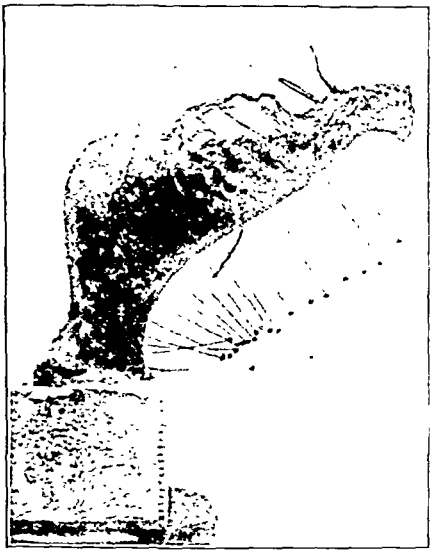


FIG. 3

*Hyperextension in the cadaver. Normal hyperextension has the contour of a hockey stick. (Courtesy of P. Blakiston's Son & Co.[4])*

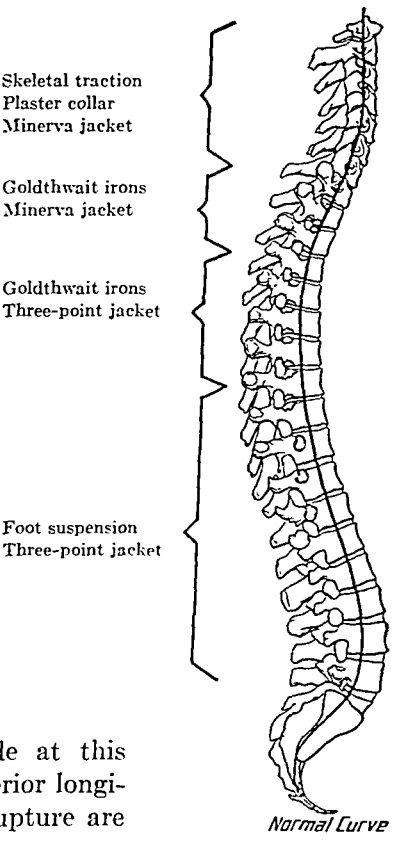



FIG. 4

Showing the several different methods of treatment used for simple uncomplicated crush fractures, depending upon the section of the spine involved. *(Courtesy of P. Blakiston's Son & Co.[3])*

Certain reservations must be made at this point. Conditions under which the anterior longitudinal ligament undergoes horizontal rupture are conceivably as follows: When sufficient shear stress is exerted to move the thoracic section horizontally on a fixed lower section (*e.g.*, coal mine cave-ins), or when the subject falls from a height back foremost, striking a projecting part at right angles to the spine, according to the tensile tests in such a case the vertebra would be expected to rupture in the mid-centrum and the ligament to rupture transversely. Such a case actually occurred. The patient was catapulted out of the car and landed across a railroad rail, but the ligament was not ruptured. He had a fracture-dislocation with paralysis. The spine was carefully hyperextended, and the patient recovered full function. This hyperextension cause of avulsion fracture is extremely rare, occurring only once in this series. The causative mechanism in this case is directly opposite to the usual flexion. The weight of both ends of the torso is levered sharply against the middle, which produces narrowly localized hyperextension. If the conditions are thus made sufficiently exacting, rupture of the midmost portion of the centrum and ligament may be expected. Such a conjuncture of conditions is, however, highly improbable.

In the case of the shear stress, if the patient lives, the cord has usually

The ligament parted in the mid-centrum in each case except in one in which it parted at the upper edge. Analysis of this exception forced the conclusion that in this case the mounting was at fault, since the break occurred at the edge of the cord lashing.

After three stretch determinations had been made, this part of the test was omitted because of difficulty in controlling the slipping of the specimen on the rod, the time of suspension apparently having to do with the firmness of the hold. It is realized that results from only three cases provide meager information; nevertheless, the findings in the three cases were surprisingly consistent.

In no case was a measurable yield recorded up to 150 pounds. From 150 up, the yield was of the nature of a straight line,—that is, an average of .037 in two inches for every additional fifty pounds above 150.

Against these determinations, the pull in pounds necessary to reduction was made on normal living patients of a body weight ranging from 150 to 225 pounds. In addition, a typical crush fracture of the first lumbar vertebra in a male weighing 165 pounds was reduced with the typical foot suspension regularly used to-day. (See Figure 2.) Chatillon balances were interposed between feet and suspension spreader. The records show a minimal pull of thirty pounds per leg and a maximal pull of forty pounds. Actual reduction required thirty-three pounds per leg, or a total of sixty-six pounds. Since the maximal pull required is eighty pounds and the minimal breaking strength 160 pounds, the safety factor is in the ratio of 2 to 1 at the lowest, 7 to 1 at the highest, and 4 to 1 as an average. The relative absence of elasticity indicates that duration of suspension has little if any effect in relation to yield of the ligament.

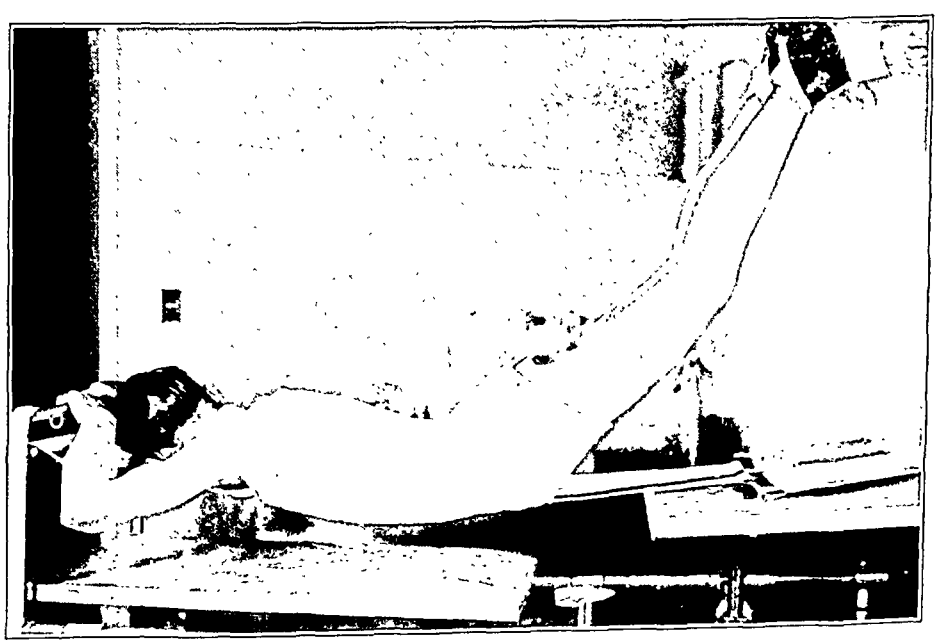


FIG. 2

Typical foot suspension and jacket as used for uncomplicated thoracolumbar crush fractures during the past eight years.

head, shoulder, and neck section meanwhile is allowed to sag of its own weight off the ends of the irons. The Minerva jacket, including head and neck as it does, is necessary to retain the reduction. Obviously the head requires just sufficient support for comfort of the patient during application of the jacket. The reduction is accomplished through gravity of the head, neck, and shoulder girdle against the fixed thoracic spine.

*Fractures of the Cervical Vertebrae*

1. Roll the patient on his back, with padding under the neck.
2. Send the patient on a stretcher directly to a hospital bed. Apply halter traction with the spine in hyperextension, using a five-pound weight. Elevate the head of the bed.
3. Make a neurological examination.
4. Take an x-ray, using a portable machine.
5. Make the Queckenstedt test if symptoms indicate the need of it.
6. Decide whether conservative treatment or laminectomy shall be used.
7. Apply skeletal traction or a plaster collar immediately, depending on the condition of the patient.
8. Check neurological status at intervals.

Where the intervertebral disc appears to be involved in a spinal fracture—that is, where the intervertebral space is definitely narrowed—rupture into the vertebral substance or subdural space is suspected. This factor affects the sequence of treatment. If neurological signs cannot be explained by fracture, the disc is held responsible until some other factor is proved to be the cause. In the absence of neurological signs, the nucleus is assumed to have escaped through a fissure or bone space. It is thought that the element of traction contained in foot suspension may mitigate the vertebral atrophy which follows such lesions. No typical bone atrophy has been found in the series presented.

## DISCUSSION OF TREATMENT OUTLINED

Contrary to recent citations in the literature of foot suspension, no roentgenogram is taken during the suspension; nor is the patient watched for symptoms or signs of impending paralysis or root pressure. There has been no reason for this precaution. No anaesthetic is used. No opiates are ordinarily used. In cases where immediate reduction by foot suspension is contra-indicated—where prohibitive complications such as shock, cerebral involvement, or multiple fractures interfere—the spinal fracture is extended or partially extended on a frame, not hyperextended, or the patient is kept prone with permission to raise himself on his elbows until he becomes eligible for adequate treatment.

Where laminectomy appears to be indicated, shells are first applied with the spine in hyperextension for cases of thoracolumbar fracture; bivalved plaster collars are used in cases of cervical fracture. A number of the patients in the author's series have recovered from varying degrees

been irreparably damaged by the same horizontal force, rendering all treatment futile. Many such fatal cases occur in mines, in heavy industries, and in mutilating car accidents.

## OUTLINE OF TREATMENT

When the spine is normally hyperextended, it resembles in contour a hockey stick. (See Figure 3.) Methods of reduction should aim to simulate this curve. Variations in anatomy and flexibility alter the degree of curvature. When the pelvis swings clear, the 45-degree pull of foot suspension tautens the ligament regardless of flexibility or anatomical variations. It is useless to attempt to extend all parts of the spine equally. The thoracic section merely acts as a fixed point against which the lumbar spine is levered. The thoracic spine is relatively immobile. The following outline is based essentially on foot suspension except for high thoracic and cervical fractures. (See Figure 4.) It depends upon a taut ligament for restoration of form.

*Fractures of the Lumbar and Lower Thoracic Vertebrae*

1. Give first-aid treatment. Roll the patient into the prone position at the site of the fracture.
2. Take an x-ray.
3. Make a neurological examination; if there is nerve involvement, make a careful analysis. Individualize treatment as outlined under discussion.
4. If there are no paralytic symptoms, reduce the fracture immediately by the foot-suspension method, and apply a three-point-pressure jacket extending from the clavicle to the pelvis. Do not give an anaesthetic or any narcotic.
5. On the next day take a check-up roentgenogram. If this shows insufficient reduction, remanipulate, using thrust if necessary.
6. Take another check-up roentgenogram.
7. Keep the patient recumbent for six weeks, free to change position, but not to sit up.
8. Then shorten the jacket, or, if there has been loss of weight, change the jacket. Again check the results roentgenographically.
9. Allow the patient to be ambulatory for six weeks.
10. Remove the jacket and take a careful detailed Bucky x-ray. Warn the patient at this time against lifting heavy weights in the stooped position. Give postural exercises to develop the abdominal muscles.

*Fractures of the Intermediate Thoracic Vertebrae*

The same sequence obtains in fractures of the mid-thoracic vertebrae except that Goldthwait irons are used instead of foot suspension.

*Fractures of the High Thoracic Vertebrae*

These fractures also are reduced on Goldthwait irons. A Minerva jacket is immediately applied. The torso is supported by the irons; the

TABLE III

ANALYSIS OF SEVEN CASES WITH RESIDUAL SYMPTOMS

| Type of Fracture | No. of Cases | Symptoms | Remarks |
|---|---|---|---|
| Thoracic vertebrae..... | 1 | | Wedged vertebra. Restricted to work as salesman. |
| High thoracic vertebrae.... | 1 | Unable to raise both arms forward simultaneously. | Returned to work as secretary. |
| Lumbar vertebrae..... | 2 | Lameness of back (1). | |
| | | Weak back (1). | Returned to former occupation. |
| Cervical vertebrae..... | 3 | Pain in neck and shoulder (1). | |
| | | Slight anaesthesia in clavicular region (1). | |
| | | Partial numbness in lower extremities (1). | |

induce the necessary perpendicular structural trabeculations for unrestricted weight-bearing. The difference in stress lines between the roentgenograms at the end of six weeks and three months is evidence of this point. There have been notable exceptions to the above rule of thumb. A few unruly patients have gotten up shortly after the initial reduction, have continued otherwise under treatment, and have suffered no penalty. The explanation for this is well known. The posterior arch bears all the weight in a properly hyperextended, well-fitting jacket. Corpulence, loss of weight, and arch fractures are the chief reasons which deter us from earlier activity.

## END RESULTS

Table II shows the end results in 115 cases which have been followed up during the past six months. One hundred and four patients recovered and eleven died. Of the 104 patients, forty-three were day laborers or did heavy work; thirty-three did light or sedentary work; and twenty-eight were housewives. Seven patients recovered with residual symptoms as shown in Table III. Of the eleven fatal cases, seven were fractures of the cervical vertebrae and the patients died shortly after fracture; two were fractures of the thoracic vertebrae and death followed shortly after fracture; two were fractures of the lumbar vertebrae and the patients died six months and one year after fracture. At autopsy destruction of the cord was found in six cases of fracture of the cervical vertebrae and in one case of fracture of the lumbar vertebrae.

During the thirteen-year period in which the 132 fresh crush fractures were seen, injuries to the intervertebral disc were found in fourteen cases. Fusion was done in six of these cases with a questionable result in one case.

TABLE II

END RESULTS IN 115 CASES FOLLOWED UP DURING PAST SIX MONTHS

| Type of Fracture | Cases Treated | Returned to Former Occupation | Residual Symptoms Present | Died |
|---|---|---|---|---|
| Odontoid process | 3 | 3 | 0 | 0 |
| Cervical vertebrae | 27 | 21 | 3 | 7 |
| Thoracic vertebrae | 19 | 17 | 2 | 2 |
| Lumbar vertebrae | 66 | 63 | 2 | 2 |
| Total | 115 | 104 | 7 | 11 |

of partial paralysis. Two patients with complete paralysis of the cervical spine have also recovered. One recovered completely; another with very slight spastic leg signs of a permanent nature recovered sufficiently to return to his former occupation.

It is becoming increasingly clear that hyperextension is a better decompressor than laminectomy for the reason given before,—namely, that hyperextension increases all diameters of the intraspinal space by removing the impinging bone at the site of the fracture.

## CONVALESCENT CARE

Roughly, in from three to four months there is a return to former occupation in unparalyzed cases regardless of whether the fractures are cervical, thoracic, or lumbar. In those cases where the occupation is sedentary or very light, the patient returns to work, if work is possible in a jacket, in from two to three months. These periods are necessarily somewhat arbitrary for the reason that sufficiently firm callus cannot be readily exhibited roentgenographically. Tenderness on deep percussion over the involved centrum is a more dependable criterion. There is no tenderness in a completely recovered case.

The reason for six weeks of recumbency is mainly that which pertains to fractures of all other parts of the body. According to the general rule, physiological rest is guaranteed by recumbency in a jacket which permits a change of position in the horizontal plane, but disallows sitting or standing. Allowance is always made for the possibility of fractures of the accessory processes whether or not roentgenographic proof is present. While Mensor and others have shown these fractures, they are ordinarily not subject to exposition; therefore, they must be assumed to be present but hidden by the dense overlying cortical shadow. When present, the imposition of body weight above the fracture induces shear stress with the possible sequelae of excess callus and pressure radiculitis.

It is considered important to institute ambulatory treatment at the end of six weeks. Again by analogy, it is assumed that bone differentiation has occurred. The vibrational influence of walking [1] then serves to

# CELLULOSE-COMPOUND CASTS USED IN THE TREATMENT OF ARTHRITIS *

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A light-weight, durable, waterproof cast, which will transmit x-rays without obscuring shadows, has long been desired to replace plaster-of-Paris. Fortunately, a recent discovery [1] has made available to the medical profession a cellulose compound long used in industry. A very convenient product is now available in the form of a roll of unbleached cotton sheeting, cut on the bias in two-inch and three-inch widths, ten yards long, impregnated with solvent, and contained in a hermetically sealed can ready for instant use.

Briefly summarized, the physical and chemical properties of this compound belong to the realm of colloidal chemistry in contrast to crystallization of plaster-of-Paris. Boric acid and a safety type of pyroxylin, containing only 12 per cent. nitrogen dissolved in acetone, form the adhesive constituents. When the acetone has evaporated, the hard cast is no more inflammable than wood. It is much safer to handle when wet than collodion.

Although when applied to the bare skin no irritation has been observed, usually the cast is applied over a layer of stockinet or sheet wadding. Hardening is slower than it is when plaster-of-Paris is used, but after forty minutes the cast is quite firm. Drying may be facilitated by using an ordinary radiant-bulb lamp and plenty of ventilation. Very little objection to the odor of acetone, which disappears with drying, has been expressed by any patient. Although rubber gloves are usually used by the operator, they are by no means necessary, since a little petrolatum on one's hands prevents the bandage from sticking to the fingers. Attention must be called to the fact that, if the cellulose-compound bandage is stretched and applied tightly, there will be a certain amount of shrinkage upon drying, but this shrinkage is not appreciable if the bias bandage is carefully applied without its width being narrowed. Also, cylinders tend to curl slightly unless an even number of layers are applied with alternate layers reversed.

Because of certain outstanding advantages over plaster-of-Paris—mainly lightness in weight and some resiliency—forty-two cellulose-compound casts have been applied on twenty-four patients with arthritis, with results which were favorable beyond expectation. A desire to have all plaster-of-Paris casts replaced by cellulose-compound casts was quickly sensed in the wards of arthritic patients soon after one or two

* Read before the Boston Orthopaedic Club, January 10, 1938.

Thirty cases of old fracture with disabling symptoms, which had been treated by others, were also seen. Fusion was done in thirteen of these cases. Several of these patients had some residual disabling symptoms following the fusion. Most of them, however, have returned to their former occupations without disability. No exact analysis of end results in these fused cases has been attempted.

## SUMMARY

There is more certainty regarding return to former occupation in the average uncomplicated crush fracture than there is in the case of fracture of a long bone. Reductions are more complete, union more certain, and malunion well nigh impossible. There is no threat of soft-part interposition.

At present the complete treatment of a simple crush fracture is less time-consuming and involves less work than most long-bone fractures. Present practice allows the dependable patient to leave the hospital in a day or two to spend six weeks recumbent at home. Three or four after-calls suffice to restore him to his former occupation. This sequence is rapidly becoming average.

Tensile-strength and elasticity tests indicate competence of the anterior longitudinal ligament far beyond the necessary strength required for reduction by hyperextension. Additional proof of adequacy is afforded by the 132 cases in which reduction was accomplished without evidence of damage.

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cases of tuberculous osteitis (Cases 3 and 5), the superior ramus alone was the seat of the process; and in three cases (Cases 2, 7, and 8), the destruction affected both the tuber ischii and the superior ramus and reached the level of the edge of the acetabulum. In the remaining cases (Cases 1, 4, and 6), the process was principally localized to the tuber ischii and the adjoining parts of the superior ramus. Also, in two of the cases of unspecific osteitis (Cases 10 and 13) the destruction reached the acetabulum. Although in several of the cases juxta-articular foci existed, they do not seem to have had the same catastrophic influence on the joint as do those juxta-articular foci which are situated in the collum femoris, in the greater trochanter, or within the ilium. As has been pointed out, there has been no case in the present series in which a coxitis has developed on the basis of an osteitis of the superior ramus. One may thus consider it especially characteristic of this form of osteitis, whether of tuberculous or of unspecific origin, that it does not lead to coxitis. Osteitis of the superior ramus of the ischium does not show any tendency to ascend and thus break through into the hip joint. This is much more difficult to explain, as in cases of coxitis there is not infrequently found a destruction descending from the hip joint along the superior ramus of the ischium. As recently performed vascular anatomical investigations have shown[2], it does not seem possible, in any case, to explain these facts as being due to the blood supply within the ischium and the hip joint.



FIG. 4-A
Case 3. After operation.

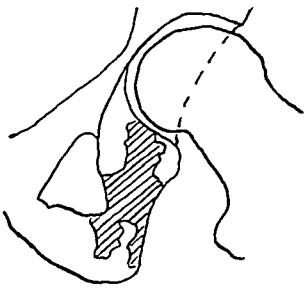


FIG. 4-B
Case 3. After operation.

In the earliest stages of tuberculous osteitis of the ischium—that is, before any objective clinical or roentgenographic symptoms have developed—all those states of ill-health which are generally classified under



FIG. 1

Demonstrating the amount of correction obtained by cellulose-compound cast at the end of three weeks.

patients experienced the change in their retentive apparatus. This cast has been employed in treating all kinds of arthritis with consistent approval of its use in each type.

For example, in rheumatoid arthritis in those patients under treatment for correction of deformities after the acute stage of the disease had become quiescent, where plaster-of-Paris had been tried numerous times unsuccessfully, cellulose-compound casts were tolerated with much less discomfort. The most outstanding example of this occurred in a young woman, twenty-four years of age, whose rheumatoid arthritis had begun at the age of twelve years. On admission to the hospital, examination revealed involvement of practically every joint in the body. She had flexion deformities of both knees. Plaster-of-Paris cylinders had been applied several times for the purpose of correction. Each time, the patient complained of such severe discomfort that, during her three-year stay in the hospital, she could not tolerate any plaster cast on her legs for over fifty-six hours at a time. On November 11, 1937, two cellulose-compound cylinders were applied to the lower extremities. After four days, these casts were cut back of the knees in such a way that throat sticks could be used for wedging the cast open posteriorly. The patient stated that she was able to move about with less discomfort with them on than off. At the end of three weeks, twenty-six throat sticks had been inserted back of each cylinder (Fig. 1). At that time the cylinders were removed and new ones were applied. Wedging was started again. After four

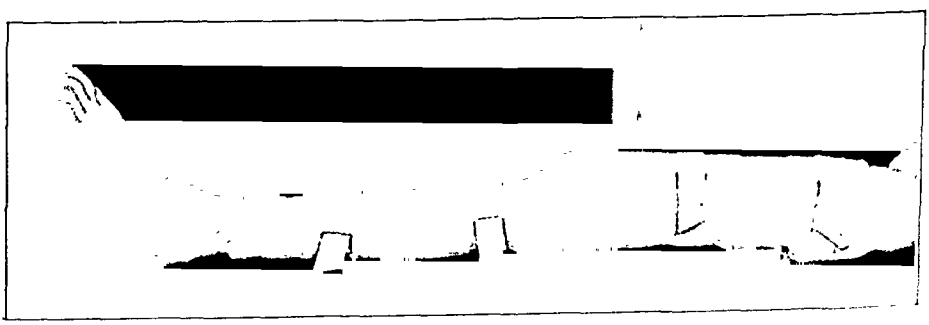


FIG. 2

Cellulose-compound cylinder applied after the left knee had been extended.

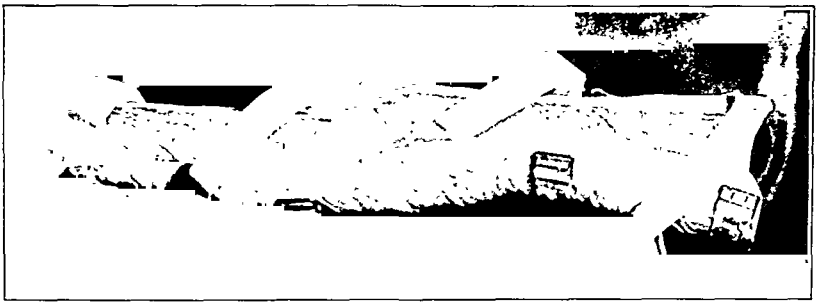


FIG. 3

Cellulose-compound cylinder shown in Fig. 2, removed to show detail. Note the extreme thinness. A longitudinal strip, the width of the patella, has been cut out anteriorly.

weeks more, the knees were completely extended. The patient stated that she could tolerate these casts because of their extremely light weight which allowed her to move about freely in bed, whereas the plaster-of-Paris casts had always been so heavy that she had never been able to move about without assistance.

In the treatment of both bed and ambulatory patients with arthritis, cellulose-compound cylinders have proved a very valuable adjunct to physical therapy. A patient who was bedridden with rheumatoid arthritis had ankylosis of both hips and of the right knee in such a position that he was unable to sit or to stand. Arthroplasties of the left hip and knee were performed. Physical therapy was started in the Hubbard tank as soon as the wounds had healed, but the patient complained of severe pain in the left knee joint. Therefore, all active motion had to be stopped until a cellulose-compound cylinder was applied (Figs. 2 and 3). With this waterproof, light-weight support, painless exercise under water was carried out regularly and effectively (Fig. 4). Within a few weeks' time a

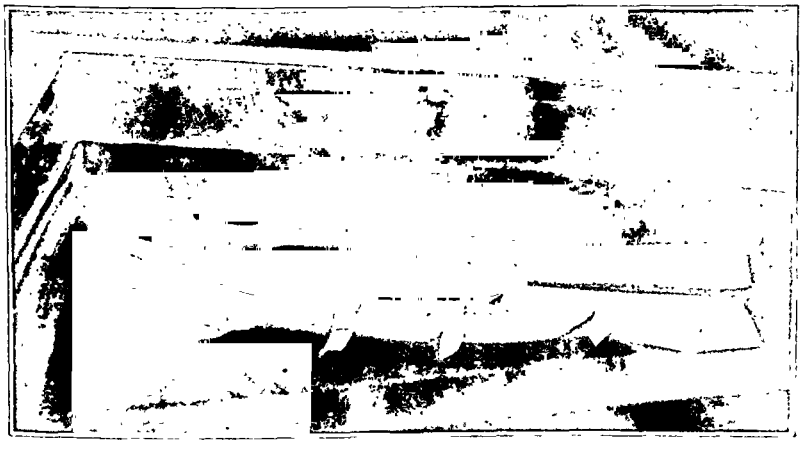


FIG. 4

Demonstrating the actual use of the cellulose-compound cylinder for underwater exercises in the Hubbard tank.

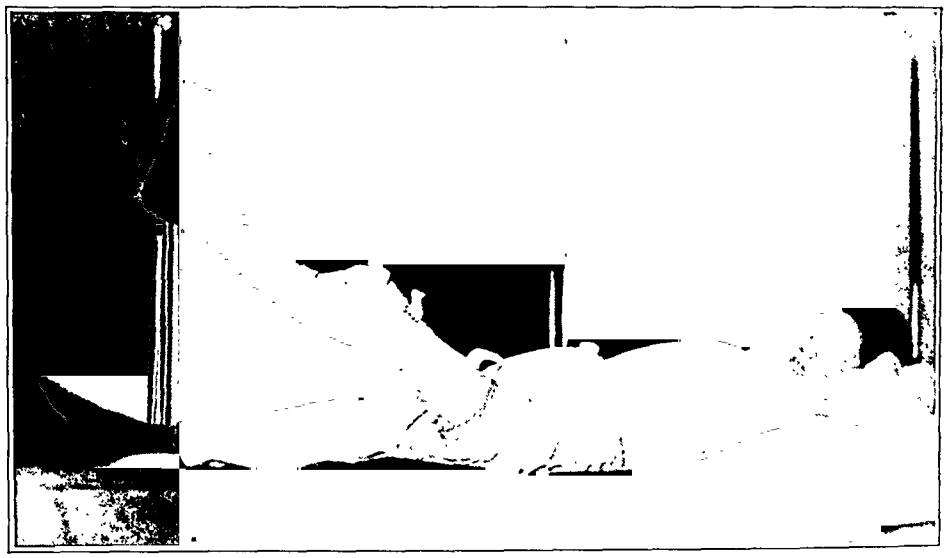


FIG. 5

Showing the ease with which the patient can lift the leg and cast against gravity.

partial weight-bearing walking caliper was fitted. The patient was then able to begin walking again after a lapse of ten years. He wore the cellulose-compound molded cylinder inside his walking caliper.

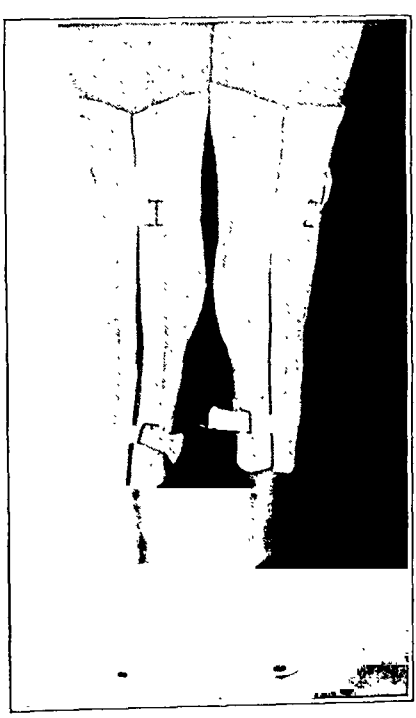


FIG. 6

Anterior view of a pair of cellulose-compound walking cylinders. Note the neat appearance which is made possible by the elasticity of the material which permits it to conform to the parts to be protected.

In a case of septic arthritis of the knee with secondary osteomyelitis, it seemed impossible to apply a plaster-of-Paris cylinder which would last more than a few days before it would become contaminated, discolored, and malodorous from the profuse discharge. Nevertheless, a plaster-of-Paris cast was made, using steel bars to form struts over windows necessary for dressings. This arrangement was so cumbersome and heavy that the patient had to lift his leg with his hands whenever he moved in bed until a cellulose-compound cylinder was substituted. The patient was delighted because of the ease with which he could move about with the use of his own leg muscles. The cast was cut down the center of the front (since bivalving is unnecessary with such elastic material) to permit its occasional removal for dressings. It did not absorb purulent, malodorous sinus discharges, and it did not become boggy and soft. The patient would very proudly lift his leg into the air to demonstrate his new achievement, and incident-

ally benefited by this exercise (Fig. 5). After wearing this cast for four weeks, the patient was permitted to start walking with a non-weight-bearing Thomas-band walking splint with a patten bottom. With this splint he also wore a light-weight walking cylinder of cellulose compound, which gave adequate protection to the sensitive knee joint.

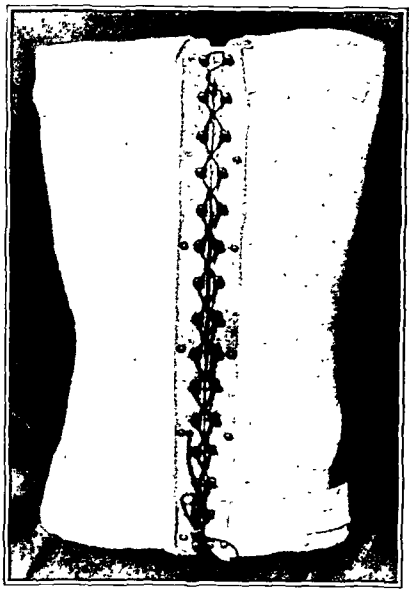


FIG. 7

Cellulose-compound jacket with a strip of hooks bradded on either side to facilitate lacing.

In treatment of aged patients with osteo-arthritis, and likewise in the treatment of ambulatory patients with arthritis of the knees whose joints are quiescent when the patients are recumbent but become swollen and painful on attempted walking, so-called walking cylinders have been used with excellent results. Previously, molded plaster-of-Paris posterior slabs were used which were similar in shape to so-called "ham" splints. Such splints, however, gave relatively little support to the lateral ligaments of the knee joint as compared with the new cylinders depicted here. The resiliency of the cellulose-compound cylinder permits removal and reapplication without destroying the shape and accurately fitting qualities. Furthermore, the cylinders easily remain in place and do not slide down onto the ankles of the patient during walking (Fig. 6). The actual weight of each of these casts, complete with buckles and straps, is about ten ounces.

From the standpoint of economy, in the treatment of Strümpell-Marie arthritis involving not only the spine but rib articulations, shoulders, and hips, cellulose-compound jackets, constructed over a torso such as is used for the making of molded leather jackets, can be furnished for about one-quarter of the cost of the leather jackets. (See Figure 7.) The molded, tempered back steels can be incorporated in the cellulose-compound jacket just as in a leather one. The finished product is not only much thinner, lighter, and cooler, but it tends to hold its shape better because it is tougher and will not deteriorate after excessive perspiration in hot weather. Incidentally, one of our patients had a rather marked structural scoliosis as well, which also received some support from this jacket.

Futhermore, when a Böhler walking iron is incorporated in a cellulose-compound cylinder, the iron does not rust, but remains suitable for use on another patient.

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# THE NEUROLOGICAL ASPECTS OF INJURIES TO THE SPINE *

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It may be granted at once that destructive damage to the spinal cord cannot be repaired, that no regeneration occurs, and that destructive lesions are in no way amenable to surgery. A number of pertinent questions, however, may be asked, although there may be some debate over the answers. For example, one may inquire whether the factor of continuing compression of the cord by displaced bone is important, and particularly whether or not the relief of such pressure will aid in restoring function. Again, in the presence of displaced vertebrae, particularly in the cervical region, with evidence of complete interruption of function in the cord, is it possible that restoration of the normal alignment of the spinal canal will permit any return of function? If there is evidence of an incomplete lesion of the cord, can surgical intervention minimize the effect of the injury and permit a better outlook for the future? How often is hemorrhage a factor in causing paralysis? If intra-medullary hemorrhage is present, what can be accomplished by surgery? Under what conditions is surgical intervention desirable?

These are some of the questions which recur. The writer does not believe that answers by neurological surgeons of experience would vary widely, although there is little doubt that earlier in their careers most of them were much more optimistic about the possibility of accomplishment by operative treatment than they became later. In general, any very great enthusiasm for operation in more than a small percentage of cases is confined to the less experienced. In this regard, the author is not speaking of injuries to the lower spine, below the level of the first lumbar vertebra, in which the situation is altogether different. There we are dealing with nerves of the cauda equina, below the level of the spinal cord.

Actual compression of the spinal cord arises from narrowing or distortion of the spinal canal, or enlargement of the cord itself from intramedullary hemorrhage or swelling. In such instances it is generally felt that maximum recovery of the cord cannot be expected unless this compression is relieved. Possibly there is an element of truth in this statement. Usually, however, there seems to be an entirely unwarranted optimism as to the possible accomplishment. Continued compression of the cord can conceivably cause a local ischaemia and produce secondary changes in addition to those primarily caused by the trauma. In a cord which has been damaged but not destroyed, can continued pressure produce further changes? In this connection, the writer believes that an

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

analogy can be drawn between the brain and the cord. In the experimental laboratory some time ago we conducted a large number of animal experiments in which the effects of localized pressure on the brain were studied. In these animals localized compressions of the brain were produced in various ways. In one series localized depressed fractures were caused by means of a regulated blow; in another series depressions of an equal depth were produced at operation by the insertion of a small object between the dura and the brain, without subjecting the area to a blow. These experiments led to the unmistakable conclusion that the pathological changes associated with these localized lesions arose from the manner of their production rather than from the lesions themselves. Whatever pathological changes were present in the brain were caused by the force of the original trauma. Localized compression produced in such a way that there was no immediate damage to the brain, even though such pressure continued for a long time, produced no pathological alterations other than a condensation of tissue, which promptly returned to normal when the compression was relieved. Continued pressure upon a localized area of the brain did not lead to permanent circulatory changes, degeneration, cystic formation, or any other discoverable process. While, so far as the author knows, similar experiments have not been carried out on the spinal cord, it is not easy to give credence to the idea that a compression, the result of an acute displacement, would be likely to cause symptoms of compression of the cord. It is far more probable that organic damage to the cord was caused by trauma at the time such displacement occurred. While there may be other good and sufficient reasons for securing a reposition of the vertebrae, one should not expect that this procedure will materially influence the signs that indicate faulty function of the spinal cord.

If we are correct in assuming that neurological disturbances following injury to the spine are caused by organic alterations in the cord, rather than by blocking of physiological impulses from pressure on the cord, under what conditions may surgical intervention be helpful? First, let us consider that group in which function of the spinal cord is completely lost below the level of the injury.

Recently, and deservedly, much has been written on the handling and transportation of the patient who has just received an injury to the spine. When such a patient enters the hospital, the first consideration is to determine the presence and severity of the injuries to the spinal cord and its nerves. The picture of complete paralysis from injury to the spinal cord is well known, and the flaccid paralysis, absence of reflexes, deep sensory loss, and paralysis of the sphincters are readily determined. If the motor paralysis is complete and the reflexes are lost, the briefest of examinations will determine the upper limit of the sensory paralysis. Below this upper level we wish to know if the sensory loss is complete. If the examiner will step to the foot of the bed and forcibly flex one of the patient's toes and compress it in such a manner as to cause severe pain, and if the patient

perceives no sensation whatever, the sensory loss may be considered to be complete, for otherwise deep sensibility and sense of pain would remain. If the patient perceives some sensation from this test, the interruption of the cord is incomplete. This we consider the most practical and informative part of the sensory examination. When the sensory loss is incomplete, a more detailed study is required.

Given complete interruption of function, the question may be raised: "Is this caused by complete division of the cord, or may it arise from a physiological interruption which may be temporary and dependent upon such factors as contusion and hemorrhage, much of which may resolve and permit a return of function?" In this connection, the writer may say that he has yet to see a patient who exhibited a flaccid paralysis with an absolutely complete motor and sensory loss and paralyzed sphincters, which persisted for twenty-four hours after injury, show recovery other than that limited to a few segments about the level of the injury. Additional information is gained from roentgenographic studies of the spine, both anteroposterior and lateral projections. Occasionally the deformity may be so great as to indicate a complete shearing off of the intraspinal structures. Spinal puncture will determine the presence or absence of blockage of the spinal canal, although in the writer's experience, when there is clinical evidence of complete interruption of the cord, this test has not led to improvement in the treatment of these severely injured patients. Given such a picture, the patient's comfort and the prevention of such complications as decubitus and urinary infections, are particular responsibilities. The author believes that proper use of an air mattress, inflated just sufficiently to permit its ready conformation to the contours of the patient, is of the greatest aid. With the patient on an air mattress, the knees may be moderately flexed with several pillows beneath them, giving support under the lower half of the thighs, the knees, and along the calves down to the ankles. The extremities should be so supported that the heels clear the bed, and pressure sores upon them can be avoided. A cradle over the lower extremities to sustain the weight of the bedclothes is in order, and a lamp may be provided, if necessary, to maintain the proper temperature. With such an arrangement, clean dry sheets which are kept smooth, and the use of alcohol and camphor on the skin, the patient can be adequately protected against bed sores. In our experience, catheterization and indwelling catheters, even under the best conditions, do not prevent infection of the urinary tract. The writer believes that there can be little doubt that suprapubic cystotomy with drainage is the procedure that has most to recommend it.

The skeletal injury receives the next consideration. Fixed rules cannot be laid down, and generalizations are difficult. If the severity of the injury to the cord is fully appreciated, it is obvious that the treatment of the skeletal injury itself should have as its goal the future comfort of a paralyzed patient rather than the more ambitious aim of restoring the skeletal structures to a condition satisfactory to a person who would

later be ambulatory. It may be mentioned here that complete lesions of the cord, particularly from injuries to the thoracolumbar spine, may be compatible with indefinite periods of life and a self-supporting economic status. The author has a number of such patients who have properly arranged wheel chairs and seating arrangements, and are carrying on the occupations of watch-maker and jeweler, stenographer, and radio repairer. In this group of patients, the recognition of the severe nature of the injury, treatment designed to spare them complications, and the proper handling of the psychological situation, with an early effort to restore to them some earning capacity, are the factors which we should emphasize.

Although the subject of cervical injuries will be covered by others, the writer would like to indicate here that the complete cervical injuries are so grave and the expectation of life is so short that the plans which apply to patients with injuries lower in the spine are not applicable.

Let us next consider the group of spine injuries in which varying degrees of impairment of nerve function are present, without complete paralysis. Given a spine injury with incomplete paralysis, it has been our experience that the improvement which the patient shows is usually far greater than might have been surmised at first, and that this improvement continues over a surprisingly long time. Perhaps many of the enthusiasts for operative treatment have formed their judgments from contact with these incomplete lesions and have attributed a striking improvement to the activities of the surgeon rather than to the natural processes active in repairing contused tissues. Certain factors are used as guides to treatment in injuries at various levels of the spinal cord, leaving injuries to the cauda equina out of consideration. If the motor and sensory paralyses are incomplete, the earliest observations of the patient should be thorough and detailed. Signs which are altering and paralysis which is increasing lead to very different judgment as to treatment than if such signs are stationary or showing a tendency to regress. Spinal puncture, with the determination of the presence or absence of blockage in the canal, is in order. Surgical procedures of one type or another are far more often required than in the complete lesions previously described. In the cervical region, this incomplete damage to the cord frequently manifests a predominantly unilateral injury, with a Brown-Séquard paralysis and an associated injury to roots of the brachial plexus. It is our feeling that, in these cervical injuries, restoration of the alignment of the vertebrae and restoration of the spinal canal are to be undertaken. Although our experience with such traction is very limited, it would seem that skull traction by some such method as that devised by Coleman and Crutchfield is mechanically the most advantageous and satisfactory. The use of a head halter has not met with any high degree of enthusiasm either on the part of the patient or of the surgeon, and is certainly trying and unsatisfactory. The helpfulness of a direct attack on the cervical cord by laminectomy may be seriously questioned. This

operation may be desirable in rare instances in which the spinous processes or laminae themselves need removal, but helpful intradural procedures would be most unusual to say the least. Exception may be made when there is evidence of increasing paralysis. At lower levels in the spine, patients in whom incomplete lesions of the cord show increasing signs should be operated on. Compression of the dural canal by injured laminae should be relieved. If there is blockage of the spinal canal, as indicated by the Queckenstedt test, we believe that operation is in order, even though the signs of paralysis are not increasing; laminectomy, opening of the dura, and treatment to be determined by the conditions found should be carried out. It is in this group that careful consideration of and appropriately directed treatment for the skeletal condition itself, either by bone graft or by more conservative measures, is in order.

If neurological signs are present in injuries of the lumbar spine, either with or without evidence of a complete lesion, it has been our practice to advise laminectomy at as early a time as the general condition of the patient will permit. Although in injuries of the first lumbar vertebra the tip of the spinal cord—the conus medullaris—may be irreparably damaged, the nerves of the cauda equina should be put in the best condition to permit a return of function. We have had the experience of having patients who have been brought to us with injuries of the lower lumbar spine, in whom the earliest neurological findings had indicated incomplete damage, show progressive neurological impairment and, at the time of laminectomy, we have found the filaments so matted together by scar and adhesions that little could be accomplished by the surgeon. We believe that earlier attention would have prevented such a matting together of the filaments and permitted a better outlook.

In summing up the factors which influence one's surgical judgment, certain points may be emphasized:

It is of primary importance to determine the completeness of the neurological lesion. With evidences of a complete lesion which persist for twenty-four hours after injury, surgery is probably of no benefit and permanent paralysis is expected.

In incomplete lesions combined with evidences of obstruction of the spinal canal, appropriate measures should be instituted to restore the spinal canal or laminectomy should be done to remove pressure.

Judgment of the patient's future as regards paralysis is necessary before any decision can be made. With an outlook for permanent paralysis, the need for any major surgery is most infrequent.

# AN ACCESSORY TABLE TOP WHICH ELIMINATES GUESSWORK FROM EXTRA-ARTICULAR INTERNAL FIXATION OF FEMORAL-NECK FRACTURES

BY E. W. CLEARY, M.D., SAN FRANCISCO, CALIFORNIA

When the author first undertook to do internal-fixation operations with the thigh in a position of right-angled flexion,[1,2] he was impressed by the lack of an effective mechanism for holding the limb in this position. He then undertook to devise a mechanism which would serve this purpose. The accessory table-top assembly, which is the result of this endeavor, has passed through a series of models and changes over an interval of several years. It has been used for twenty-five or more fixation operations. Its use greatly facilitates the operation, shortens the operating time, and gives the surgeon accurate guidance as to point of insertion, direction, and depth in the placement of the internal-fixation device, whether it be bone graft, screw, single or multiple nail, or locking bolt. The simplification and standardization of x-ray technique effected by the mechanism not only minimizes the strain on the patient, but lessens the tax on the time and patience of the surgeon, the roentgenologist, and the operating-room staff.

The device enables the surgeon to accomplish secure and accurate fixation by bringing precision and accuracy into three steps of the operative procedure. It provides for:

1. Secure immobilization of the reduced fracture of the hip in traction in a position of right-angled flexion of the thigh and in any degree of rotation and abduction or valgus desired.
2. Accurate x-ray localization in vertical and horizontal projections of the position of the fractured femoral neck and head with respect to the table top over which the hip is held immobile.
3. Accurate and easy transfer of the localizing information supplied by the roentgenograms into the aseptic field of operation.

## DESCRIPTION OF THE APPARATUS

A traction leg holder (Figs. 1,*A* and 3,*A*) is fixed to an x-ray permeable table top (Fig. 1,*B*) which has a cassette tunnel (Fig. 1,*C*). A lifting disk (Fig. 3,*D*), acting on the inner threaded shaft of the leg holder (Fig. 3,*E*), supplies the desired amount of traction. The degree of valgus increases proportionately to the extent that the buttock on the injured side is lifted. The leg, tied in the holder, is placed in the desired rotation and, after sufficient traction has been applied, is locked by a turn of the locking disk (Fig. 3,*F*). This accomplishes the first step.

Directing guides (Fig. 1,*G* and *H*) indicate the position of the tube center and the direction of the ray for horizontal (Fig. 4) and vertical (Fig. 5) views.

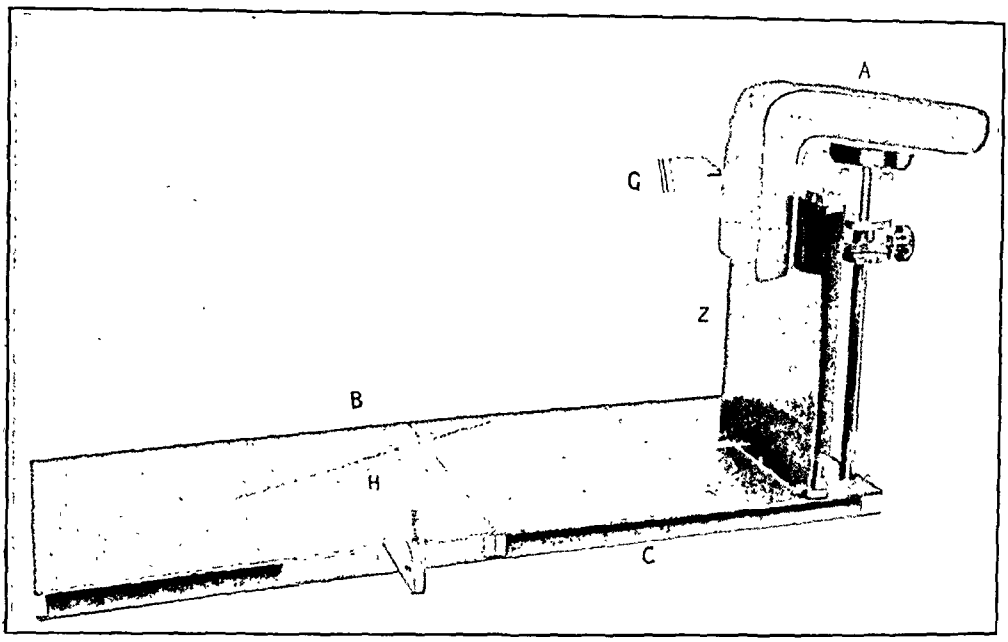



FIG. 1

*A:* Leg holder
*B:* Table top
*C:* Horizontal cassette tunnel
*Z:* vertical cassette tunnel
*G* and *H:* Directing guides for the x-ray

Plotting fields, of a substance which is not permeable to the x-ray, laid out on the intervening surfaces of the cassette tunnels appear on the negative as shown in Figures 4 and 5. In addition to the lines which form one-inch squares, there are lines laid out at angles of 10, 20, and 30

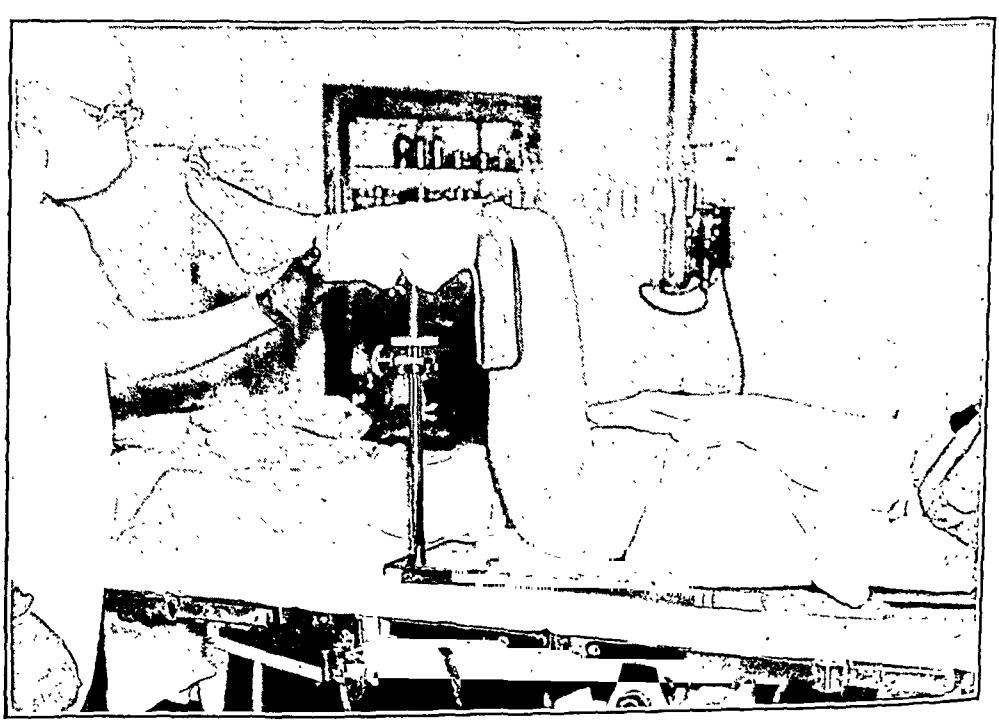


FIG. 2

Hip in position and immobilized after local anaesthetization and manipulative reduction.

degrees, so that the angle at which the central axis of the neck lies in relation to the double center line of the plotting field, or its parallels, is directly indicated. Superposition of the shadow of the bone over the shadows of the localizing plotting fields provides accurate localization, thus accomplishing the second step.

There are three sterilizable parts utilized in carrying out the final step: a post shield (Fig. 3,*Y*), a horizontal plate (Fig. 3,*L*), and a pointer instrument (Fig. 3,*M*). The post shield provides a sterile cover for the post of the leg holder. The horizontal plate locks securely to the table top, providing a large sterilized surface. Over the central portion of this plate the base of the pointer instrument slides in a slot. It may be positioned and locked, with its center in the vertical plane in which the axis of the femoral neck is shown by the horizontal roentgenogram (Fig. 4). The pointer instrument (Fig. 3,*M*) is slid into position after the lateral surface of the trochanter is exposed through the incision. This pointer instrument consists of an adjustable post mounted vertically in the center of the base plate (Fig. 3,*S*). The head of this instrument is composed of two graduated disks, so mounted and attached to the vertical post *S* that a pointer pencil (Fig. 3,*N*), sliding in a channel in the head, can be adjusted at whatever level and angle are desired to "find" for the surgeon the position and direction of the central axis of the neck of the femur.

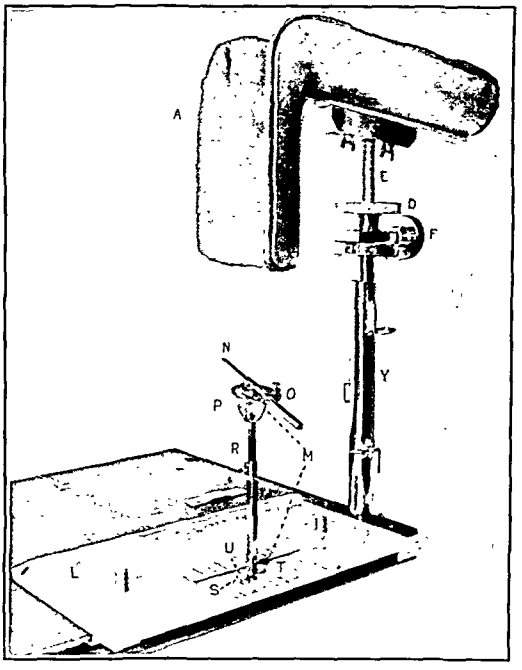



FIG. 3

*A:* Leg holder
*D:* Lifting disk
*E:* Threaded inner shaft
*F:* Locking disk
*O* and *P:* Pointer head
*L:* Horizontal metal plate
*M:* Pointer instrument
*N:* Pencil
*R:* Post
*S:* Base plate
*T:* Slide
*U:* Locking screw
*Y:* Sterile shield

The radial graduations on the vertical and horizontal disks, like the angle lines of the localizing plotting fields shown in the roentgenograms, indicate 10, 20, and 30 degrees in the horizontal or vertical views, so that the surgeon may, by reference to the roentgenograms, very quickly and easily set the pointer pencil to mark the spot where the central axis of the neck passes through the trochanteric cortex. Having marked this spot on the bone with drill or chisel, the operator may then make a second adjustment of the disks, so that the pointer pencil exactly parallels the axis of the femoral neck. When this second adjustment has been made,

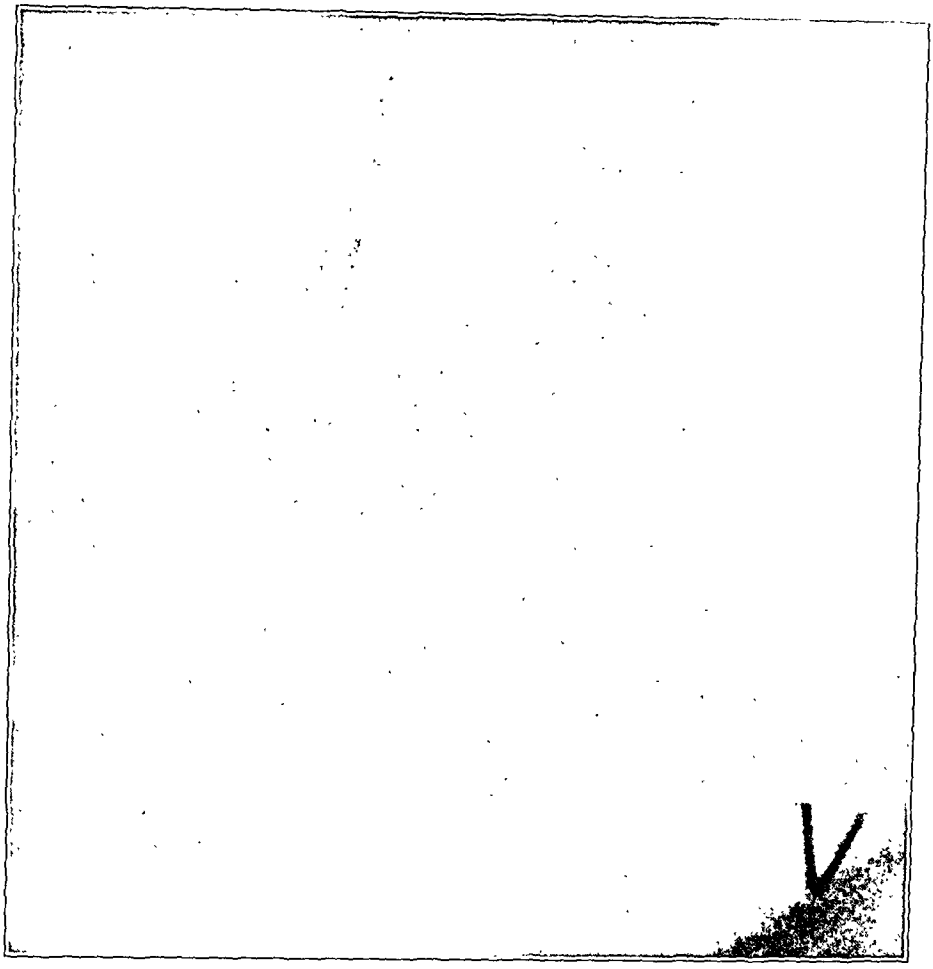


FIG. 5-A
Case 5

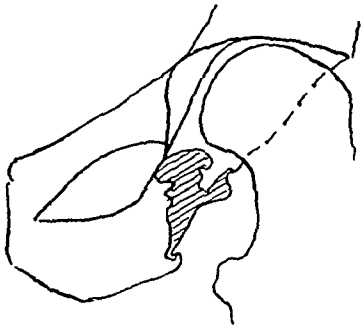


FIG. 5-B
Case 5

the common name of "sciatica" are to be taken into consideration as regards the differential diagnosis. In those cases in which symptoms similar to coxitis have been added, there has as a rule been time for so great changes to develop in the ischium that they are discernible in the roentgenogram, and for this reason there need be no hesitation as to the diagnosis. The same point of view can be applied to those cases in which an abscess or a fistula has appeared. A few patients with well-developed abscesses in the gluteal region were treated under the diagnosis of "dermoid cyst" for quite a long time before their admittance to the hospital. In those cases where there are roentgenographic changes in the ischium but no sequestra, it may often be difficult to determine whether it is a question of an inflammatory process or of a tumor. In order to exclude lues, the Wassermann test should be made.

Of the five cases of osteitis of unspecific or uncertain origin, in two (Cases 9 and 13) the disease made its first appearance in the form of a high

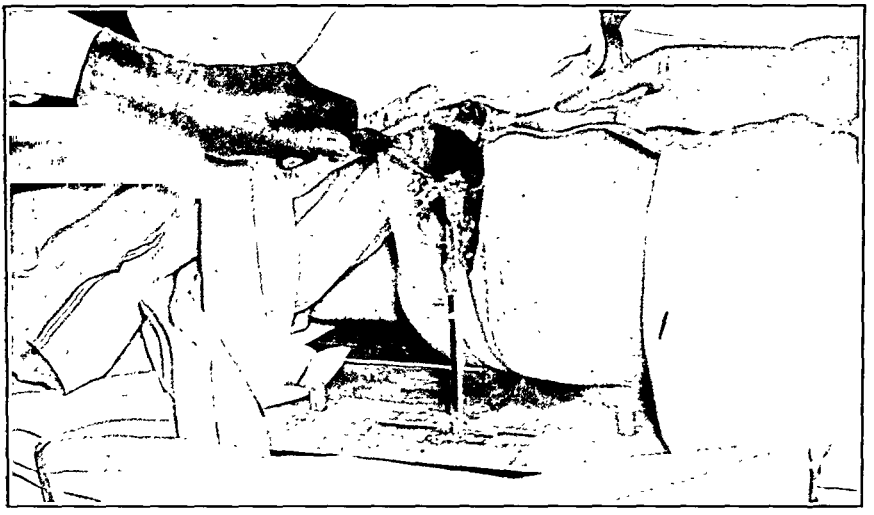


FIG. 6

Incision made and pointer instrument "set" to "spot" insertion point on cortex of trochanter.

in the "set" of the pointer. Figure 6 shows the pointer marking the position of the central axis on the cortex of the trochanter.

The entire operation of this device is much more simple and direct than such a detailed explanation might imply. Much thought has been given toward such simplification of the device as to make it practicable for the use of any surgeon familiar with major bone surgery.

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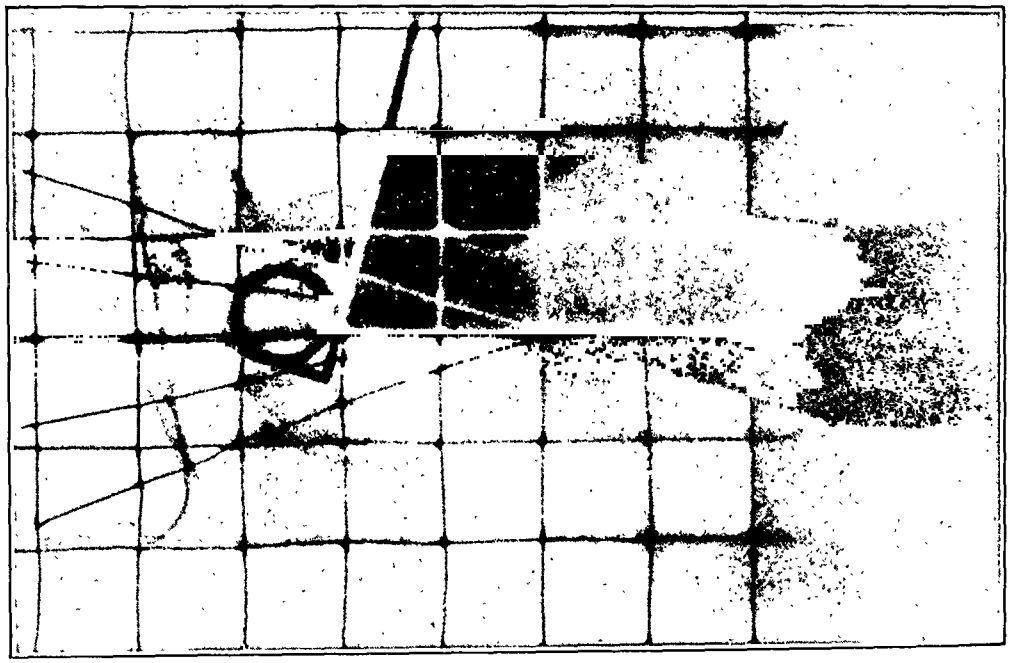


FIG. 4

Horizontal roentgenogram. This view, due to the flexed position of the thigh, gives the so-called "lateral" presentation of the femoral head and neck. Line shadows of the localizing plotting field correspond to lines ruled on the horizontal plate (Fig. 3,*L*).

the head of the instrument is lowered out of the way of the drill, and the surgeon uses the pointer pencil as a guide. If the drill is kept parallel to the pencil, it will penetrate to the femoral head along the central axis of the neck. Any advisable deviation from this course of the drill is easily determined by studying the two roentgenograms and is easily duplicated

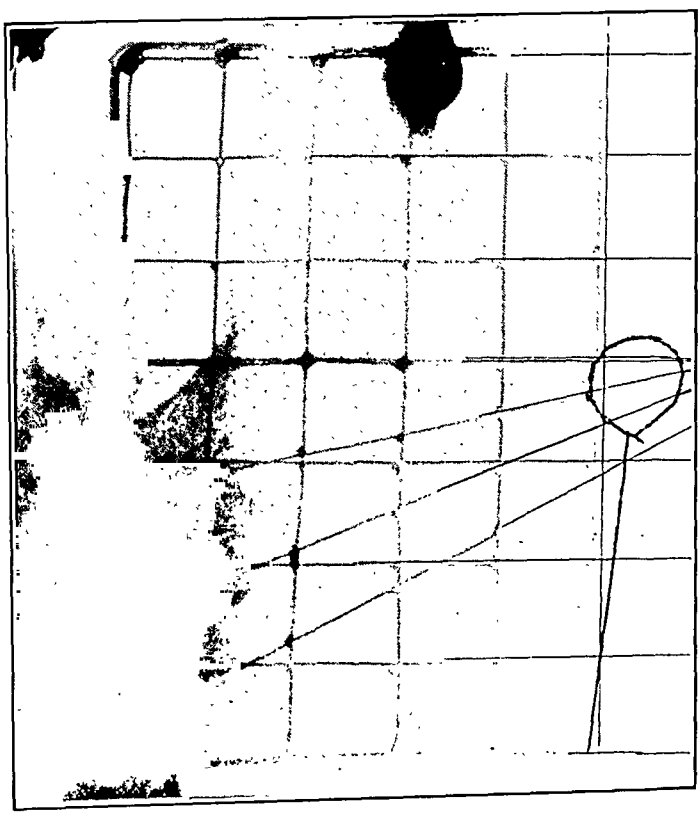


FIG. 5

FIG. 5

Vertical roentgenogram. This view gives the commonly called "anteroposterior" presentation of the femoral head and neck. Post *R* of the pointer instrument (Fig. 3,*M*) must be adjusted by means of its corresponding graduation mark to bring the instrument head to the height of the central axis of the head and neck as indicated by their position on the line shadows of the localizing plotting field.

Roentgenographic examination revealed a posterior dislocation of the second, third, fourth, and fifth metacarpals on the carpals. No fractures were observed. (See Figures 1-A and 1-B.)

The patient refused a general anaesthetic. Local infiltration into the dislocated joints with 2-per-cent. procaine produced excellent anaesthesia. Reduction was accomplished by traction and by levering the metacarpals, first with slight flexion to unlock the bases, then pressure over the bases when sufficient extension was obtained. The dislocations of the fourth and fifth metacarpals were reduced first, after which the second and third metacarpals slipped easily into place. There was no tendency toward redislocation. A split plaster cast was applied. (See Figures 2-A and 2-B.)

Later, skin traction was applied to the fingers and a sponge was placed over the dorsum of the metacarpals, as it was feared there might be posterior slipping. All support was removed after twenty-two days. Wrist and finger function was painless and normal. No further trouble has been reported.

## REVIEW OF LITERATURE

There is relatively little in the literature regarding this injury. Stimson, in 1905, stated definitely that only four cases of dislocation of the four ulnar metacarpals had been reported. Two of these were volar dislocations and two were dorsal. Most of the cases had been diagnosed post mortem. There was no information as to the usefulness of the hands.



FIG. 2-A FIG. 2-B

After reduction.

# CARPOMETACARPAL DISLOCATIONS

## Report of a Case

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*From the State University Hospital,* Oklahoma City*

This rare injury is of twofold interest: First, there occurs an injury which seemingly is impossible from an anatomical standpoint; second, very good function is usually obtained with or without reduction.

### CASE REPORT

J. P., negro, male, aged thirty-five, came to the Emergency Room of the State University Hospital on March 11, 1936, complaining of an injured right hand. The patient was intoxicated and had fallen down a stairway. He had no idea of how the hand was injured during the fall.

Examination was negative except for the injured hand, which was severely swollen. There were no marks or bruises. The hand was thickened anteroposteriorly and shortened. The proximal ends of the metacarpals could be palpated as a hard, transverse ridge across the dorsum of the wrist. Finger, thumb, and wrist motions were unimpaired except for a moderate amount of pain.

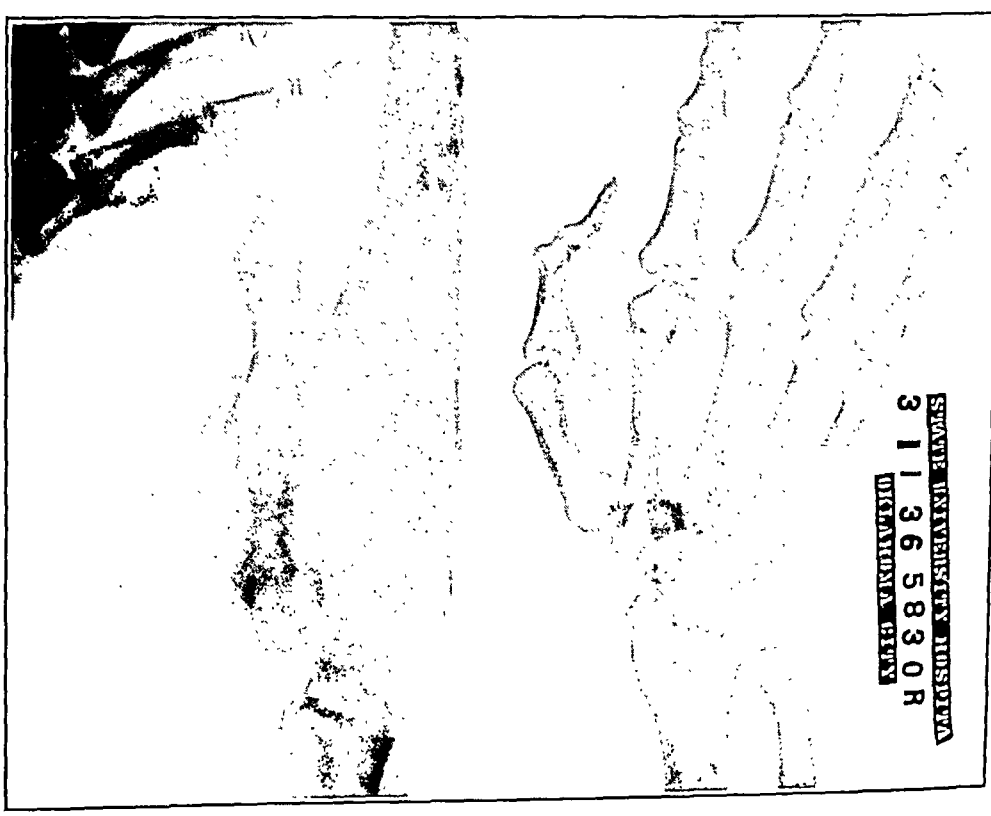



FIG. 1-A FIG. 1-B

Carpometacarpal dislocation before reduction.

* Service of Earl D. McBride, M.D.

factors enter,—namely, the state of muscle contraction at the precise moment of the injury; weakness, either occupational, acquired, or congenital; and exact conformation of the bones at these joints. With the entire carpus fixed, sudden flexion or extension of the metacarpals could result in a dislocation. The dislocation may be either anterior or posterior depending upon the direction of the force.

## SUMMARY AND CONCLUSION

Posterior dislocation of the carpometacarpal joints is a very rare injury. Due to the normal relative immobility of these joints and the fact that the tendons are not firmly bound in this region, unreduced dislocations do not produce serious disabilities. Better results, cosmetically and functionally, may be obtained by reduction, which is easily accomplished in an early case under local or general anaesthesia. Reduction of old cases should receive serious consideration before attempts are made, since the only improvement would be in the appearance of the hand, and it might be made a much less usable member.

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Hammann described a case of dorsal dislocation of the fifth carpometacarpal joint. He stated that the injury was very rare, but he did not review other cases. His discussion was primarily concerned with the mechanism of production of the injury.

Burmeister reported a case of dorsal dislocation of the second to fifth metacarpals. His patient received a strong blow on the dorsum of the hand in a car accident. He suffered little pain and refused reduction, due to lack of discomfort or dysfunction. He was seen two years later and functionally had a useful, but deformed hand.

Key and Conwell discussed briefly this injury and showed an excellent roentgenogram of the dislocation. In their opinion a backward dislocation is the most common of the dislocations. Functional results were not discussed.

Schnek reported only two posterior carpometacarpal dislocations in 437 cases of carpal injuries.

## ANATOMICAL CONSIDERATION

The carpometacarpal joints, with the exception of the first, are of the arthrodial-diarthrosis type. The second to fifth metacarpal bases articulate with the distal row of bones of the carpus by a series of elevations and depressions which fit together rather snugly. The joints are bound closely by a capsule, weakest on its radial side and composed of short fibrous slips extending longitudinally on the dorsal and volar surfaces. Two interosseus ligaments are usually present, reaching from the bases of the third and fourth metacarpals to the adjacent margins of the hamate and the capitate. The common capsule encloses the entire series of joints, both between the bases of the metacarpals and between the carpometacarpal joints.

## METHOD OF PRODUCTION OF DORSAL CARPOMETACARPAL DISLOCATIONS

Burk attempted to produce this dislocation on cadavera. Usually he obtained fractures. It was necessary for him to cut the anterior and posterior ligaments to obtain a dislocation. The author has repeated Burk's experiments with similar results. Attempts on fresh specimens with the carpus fixed were unsuccessful unless the anterior and posterior ligaments were divided. The dislocation could then be effected by unlocking the bones with flexion and pressure posteriorly on the bases of the metacarpals.

No one type of injury produces this dislocation. Direct blows may result in a posterior dislocation, as Burk has described. Bullets or automobile accidents have been known to cause it. There is almost invariably soft-tissue damage with a direct injury.

Indirect injuries unquestionably have been responsible for many of these dislocations, but the exact mechanism is vague. It is interesting to speculate on mechanical forces applied to the wrist, but any conceivable type of blow, twist, or bend might result in one of several injuries. Other

## CASE REPORT

Miss H. C., aged forty-two years, fell down a flight of stairs in her home and landed with one foot turned inward. Her family physician saw her within a few minutes, applied tincture of iodine and a sterile dressing to the wound, and sent her to the hospital. She had a compound dislocation of the tibio-astragalar joint, the astragalus being rotated through 90 degrees, so that its superior aspect presented in an open wound on the lateral aspect of the ankle. The malleoli were intact and the only fracture shown in the roentgenogram was one of the base of the fifth metatarsal at the point of insertion of the peroneus longus tendon. There was a narrow bridge of skin tightly stretched between two parallel wounds.

Operation was performed ten hours after the injury. First the surrounding skin and then the wound itself were painstakingly cleansed with abundant quantities of soap solution and water. All contused soft tissues were excised. The dislocation was then reduced and the ruptured ligaments were sutured. Very little tissue was available for the closure, and the joint cavity could only be sealed by using a flap of skin raised from the outer aspect of the leg and slid downward over the ankle. The original wound was thus closed without drainage, and the site of the sliding graft was later covered with pinch grafts. Healing took place without infection.

Partial weight-bearing with crutches was permitted four weeks after the accident. There was recovery of full range of motion at the ankle and in the foot, and, during the four years which have elapsed since the injury, the patient has been walking without pain and has had no sprains of the ankle.

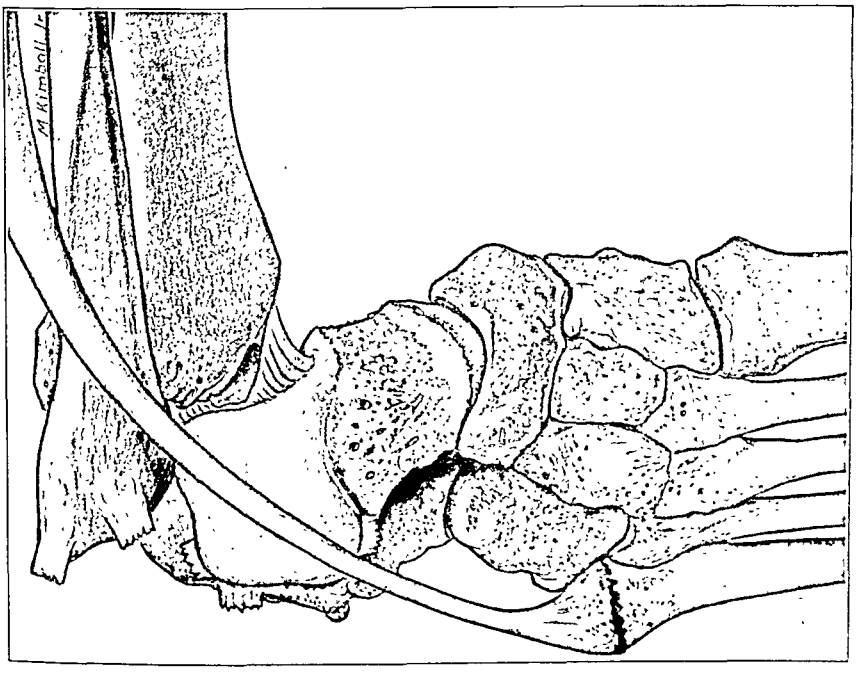



FIG. 1

Drawing showing position of dislocated foot and sprain-fracture of the base of the fifth metatarsal. The displacement of the peroneus longus tendon outside the fibular malleolus is schematic.

The treatment of such a case by débridement and suture without drainage makes for a good recovery provided of course that infection does not supervene. Primary closure was possible in this case because of the

# COMPOUND DISLOCATION OF THE TALUS WITHOUT MALLEOLAR FRACTURE

BY JOHN PAUL NORTH, M.D., PHILADELPHIA, PENNSYLVANIA

It is commonly supposed that the talus cannot be dislodged from the ankle joint by injury unless one of the malleoli or a lip of the tibia is fractured. In the main, this is true and certainly most dislocations at the ankle have associated fractures of the long bones. Lateral dislocation accompanying fractures of the Pott type is familiar to all. Posterior dislocation, which occurs when the posterior lip of the tibia is broken, is also common. Less frequently a fracture of the anterior lip of the tibia may permit anterior luxation of the foot, or upward displacement of the talus may occur if the inferior tibiofibular ligaments are torn, with resultant widening of the mortise. The case reported herewith is an example of internal dislocation of the foot without associated fracture, and there are on record sufficient cases of similar character to warrant the recognition of the possibility of its occurrence. Prior to the x-ray era such cases were described, but, lacking roentgenographic confirmation, the diagnosis is open to question. In a review of 108 cases collected by Wendel, at least one dislocation appears to have been unaccompanied by fracture. Stimson quotes Malgaigne to the effect that eight such cases were recorded prior to 1900.

The earliest authenticated case of uncomplicated dislocation seems to be that of Sievers. In this case, the tibia and fibula were intact, although there was a chip fracture of the posterior lip of the superior articulating surface of the talus. Subsequently, isolated cases have been recorded by Péraire, Gillen, Green, Pedlow, Hirschfield, Dehne, Pegreffi, Aboulker and Herbert, Conwell and Alldredge, and Sloane and Coutts. In each instance the foot was rotated inward, so that the superior surface of the talus presented below the fibular malleolus. In addition, Scharsich reported two cases of simple dislocation, thus making thirteen in all. The usual mechanism described in the production of these injuries is a fall or other accident of such nature that the weight of the body is thrust suddenly upon the outer aspect of the inverted foot. Six of the ten dislocations were compound. In one instance the navicular and in another the talus was completely extruded. These tarsal bones were replaced and, although the result is not recorded in the case of extrusion of the talus, the patient with extrusion of the navicular was able to walk normally in two months. Of the total number of cases, good functional results were reported in five cases, while in the remainder the results were not stated. One of Scharsich's patients had a fracture of the head of the fifth metatarsal similar to that in the following case.

temperature (Case 13 in connection with an angina). This fact, together with the results of other examinations (the tuberculin tests according to Mantoux were negative up to three milligrams of old tuberculin), indicates that these cases probably are to be classified as septic forms of osteitis. A case of septic osteitis described by Pouzet also set in with a high temperature. In the other three cases of osteitis of uncertain origin (Cases 10, 11, and 12), the symptoms commenced gradually and the whole disease had a protracted course, as in the cases of certain tuberculous osteitis. In two of these latter cases (Cases 10 and 12), however, the origin of the process was uncertain. Case 10 was that of a man who, at the age of twenty-three years, started to have pain in the right leg. A few years later, an abscess appeared, which was incised, and a sequestrum was extracted. A roentgenogram showed destruction of the upper lateral parts of the right tuber ischii, as well as a slight atrophy of the whole right half of the pelvis. The destruction had a blunt and blurred outline toward the tuber ischii. As only the tuberculin test according to Pirquet had been made, which was negative, and as continued tuberculin tests according to Mantoux and other examinations (the Wassermann reaction and pathological-anatomical examination) had not been carried out, it was not possible to make a definite diagnosis. The author, however, is of the opinion that the most probable diagnosis is that of tuberculous osteitis. Case 12 was also that



FIG. 6-A
Case 7. Before operation.

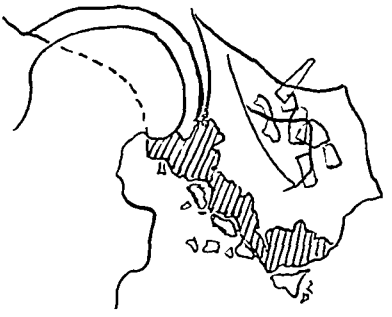


FIG. 6-B
Case 7. Before operation.

conditions under which the accident occurred, the prompt and efficient first-aid treatment, and the early stage at which operation was done. Many compound dislocations must of necessity be treated by other methods, because of actual or threatened contamination.

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# HIP FRACTURES

## Valgus Position—Accidental or Engineered

BY FREDERIC JAY COTTON, M.D., AND GORDON MACKAY MORRISON, M.D.
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It is a well-recognized fact that, whatever treatment is resorted to, vastly better results are obtained in intracapsular fractures of the neck of the femur if the displacement happens to be into the "valgus" position. (See Figure 1.)

What is new is that we have lately learned how to produce this valgus position at will, and consistently.

There is no question that with a valgus position one gets a more favorable line of muscle pull, less damaging strain from weight-bearing in the sense of cross strain, and the tendency is toward lengthening rather than shortening of the leg. We knew this long ago, and many of us have tried for a consistent technique by which we could shove the fragments into the valgus position. We failed uniformly.

And some of us did vast and futile experimentation on the cadaver and on the living, to contrive a "valgus" reduction, but with no consistent results!

Only lately, when we finally obtained "lateral" roentgenograms of adequate quality, did we realize the previously overlooked factor of forward *rotation* of the proximal end of the distal (neck) fragment.

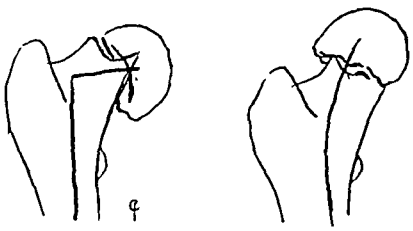


FIG. 1

*Left:* The usual "varus" position of so-called "impaction".
*Right:* The "valgus" position. Note the difference measured in cross-breaking strain.

Only with this vision was it possible to work out accurate reduction.

Prior to 1933, Leadbetter and one of the writers devised manipulation independently, curiously similar in detail, for *accurate reduction*.

The writer then expressed a hope that such accurate reduction might in itself solve the problem of absorption of the neck.

But it failed to do so. Absorption of the *proximal* fragment (independent, it seems, of the arterial nutrition of the *head*) goes on in 1938 just as in 1933.

We have moved ahead slowly and can say for the first time that a hip fracture *accurately* reduced by methods quoted can be further reduced into a valgus position with a vast advantage, and this can be done with precision.

The fact is that a hip fracture, once *accurately reduced*, can be converted into a *valgus* position rather exactly with very significant benefit as measured by end results.

The artificial impaction of hip fractures—even of hip fractures not

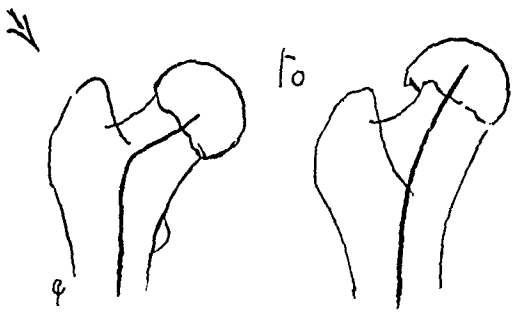


FIG. 2

*Left:* Approximate anatomical reduction.

*Right:* Impaction into "valgus". Direction of impaction *in and downward.* Note the weight-bearing line and the difference in "cross-breaking" strain.

always well reduced—dates back many years. The senior writer, followed by Smith-Petersen and many others, has done many impactions, with results which yielded at least personal satisfaction and probably great benefit.

However, these have been impactions *in the line of the neck.*

*Now* we have learned, but only lately, that we can impact a *neutral* reduction *into the position of "valgus"* to a position that we know to be far more favorable to recovery and union, and, like so many things of importance, it is ridiculously simple.

The procedure is to reduce the hip accurately by the method now in use,—namely, traction in the line of the femur, hip and knee being moderately flexed; sharp adduction; knee crossed over the thigh of the sound side; sharp inward rotation of the broken limb, followed by bringing the leg down into slight abduction (20 degrees more or less) without letting up on the inward rotation. (See Figure 2.) The result is checked both by anteroposterior and lateral roentgenograms. It may be necessary to repeat this manoeuver.

This method of reduction requires some force, and there is little chance of overreducing. In only one out of many cases have we been obliged to repeat the procedure because we had overreduced the displacement. The usual fault is in not using enough force.

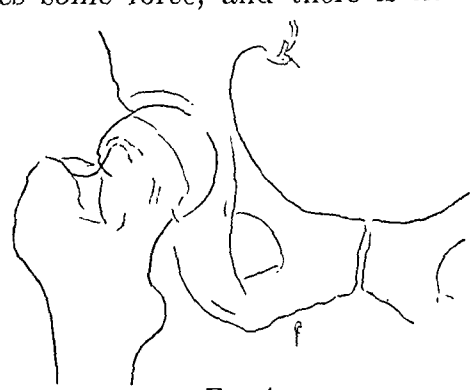


FIG. 4

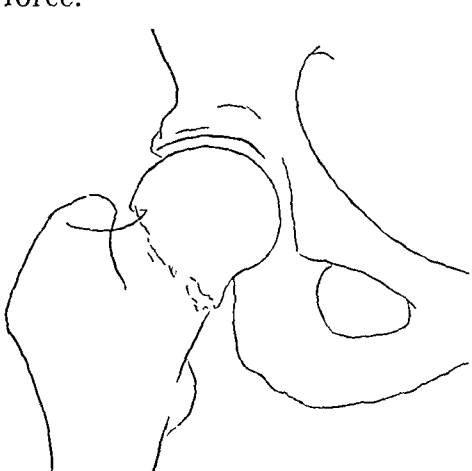


FIG. 3

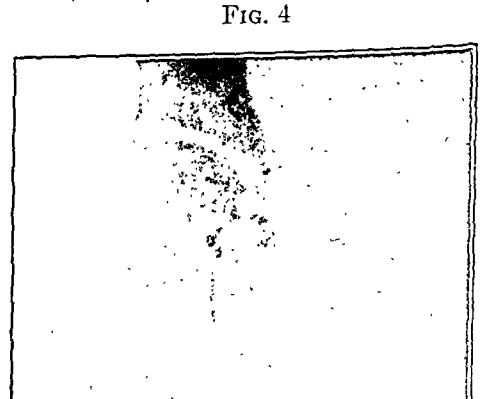


FIG. 5

Figs. 3, 4, and 5: Typical cases of accidental valgus displacement with subsequent bony union.



FIG. 6



FIG. 7




FIG. 8

Figs. 6, 7, and 8: Other typical cases of accidental valgus displacement with subsequent bony union.

When satisfactory position is attained, comes the time for converting the neutral (normal) position *into valgus by impaction.*

The leg is abducted 20 or 30 degrees from the mid-line of the body. In obese patients one cannot abduct much and still reach the trochanter to impact. We use a heavy wooden mallet to impact with, the limb being protected by a single layer of heavy felt. A tightly stuffed cylindrical sandbag of four-inch thickness can be used and with this no felt is needed for protection. We have done many impactions in this way, but we feel that the hammer gives more exact control and, with this newer impaction, exactness is essential.

With the hammer, the trochanter is struck and driven home. The blow is a slow swing of the heavy mallet.

The direction of the blow is not in the line of the neck, as with the old impaction procedure, but across it at an angle of roughly 45 degrees with the mid-line of the body.

Since the limb is already abducted, this gives a total angle of from 70 to 75 degrees or, perhaps better stated, an angle of from 105 to 110 degrees with the shaft.

The force, then, is applied in a line to push the neck fragment across under the head at the same time that the neck is impacted into the head. This can be done quite exactly with a little practice. We have never failed as yet to get the desired position.

A word of caution is necessary: It is very important that the blow be struck parallel to the table. There is a possibility of shoving the neck fragment to front or back.



FIG. 9-A

Fracture of hip with loose fragments.

Following reduction and impaction, we have nailed the fragments with Krupp nails from three to three and one-quarter inches long according to the individual case. The incision is small; drilling is done under fluoroscopic control; and the nails are inserted in the drill holes and tapped home, using a nail set.

Then, gently, the final impaction is done with the impactor devised by Smith-Petersen, which straddles the nail and rests on bone.

Suturing and dressing follow.

In only one case (when patient was convalescent) have we used a Thomas splint and in no case have we employed a plaster spica.



FIG. 9-B

After reduction. Fragments in valgus.

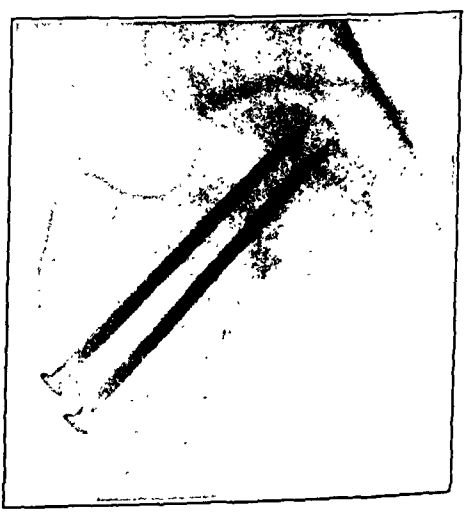


FIG. 9-C

Fragments nailed.



FIG. 10-A

First case deliberately treated by the technique described, before reduction.



FIG. 10-B

After nailing. The patient at present has serviceable bony union.

It may be well to add a brief account of the reasoning that led to the devising of this new method.

In recent years we have had occasion to treat not a few broken hips. Those that have interested us particularly are these "valgus" hips, perhaps eight in all.

These are cases, often in relatively young people, of intracapsular

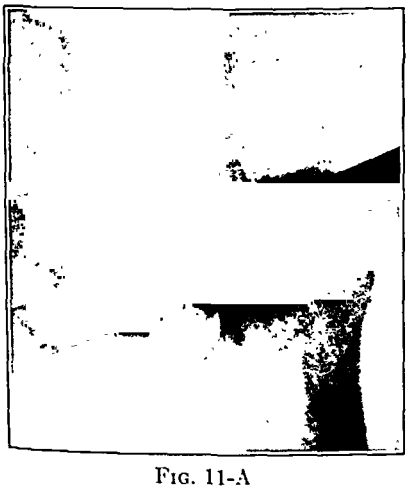


FIG. 11-A

Fracture of the hip with loose fragments.

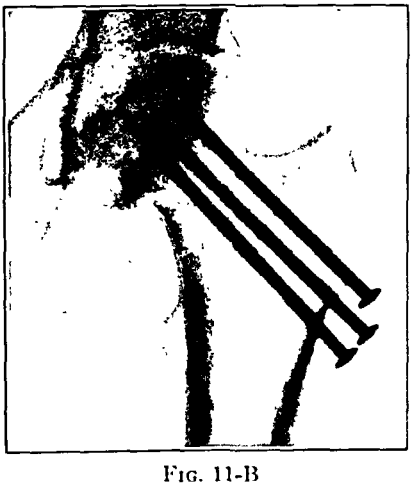


FIG. 11-B

After reduction, impaction, and nailing. Patient at present convalescent. Apparently a very favorable case.

fracture with little upward displacement and with little or no *rotary* displacement. The displacement, such as it is, is of the *distal* fragment *inward.*

The significant factor in the history—from those with any useful memory of the accident—is uniformly that of a crash *sideways onto* the trochanter.

This is an entirely different story from that of the elderly patient whose leg gives way in mid-air or who sits down half sideways in a sitting "squash" fall.

This seems most significant if we accept the stories. We *do.* In these patients the distal part of the hip is driven *inward:*

without rotation
without great displacement
without great damage to capsule
without damage to ligamentum teres
without damage to pericapsular vessels.

And, therefore, they do well from the start, and the course of repair is continued without the handicap of any cross strain from muscle pull or weight-bearing.

It is scarcely to be hoped that in cases of different initial mechanism, of greater soft-part damage, that a reproduction of the valgus position can bring the worst cases quite into the better class, but we believe it to be a very important factor.

No claim is made that such reduction with impaction has any effect in avoiding or reducing the "death of the head" * or the aseptic necrosis and absorption of the near end of the distal fragment, due, one supposes, to damage of the blood supply, mainly arterial. Over these calamities we have no control as yet.

But, if the neck (spiked or unspiked) is going to absorb, then the val-



FIG. 12-A

Fracture of the hip with loose fragments.

* Real, but a bit overplayed perhaps—not usual or common.



FIG. 12-B
After reduction.



FIG. 12-C
After impaction.



FIG. 12-D
After drilling under fluoroscope.



FIG. 12-E
After nailing.

gus position is the posture in which the bone may best resist this misfortune.

A very considerable number of such cases (the neck absorbed) go on (protected) within a year to bony or, at worst, *serviceable close fibrous* union, whatever the exact detail of treatment. But these are usually "valgus" cases.

We believe this matter of *controlled* determination of position to be very important.

It is too soon to talk of results. Probably they will not be consistently good, but we believe they will be better.

After all, this whole problem of intracapsular hip fracture is only for the optimist.

Some of those who have worked on it for thirty years have the bitter taste of failure and a bit of skepticism about reported 100-per-cent. results.

*But*, results *can be bettered*, *are being bettered*, and this matter of controlled reduction into valgus may well prove an important factor.

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# A BONE PLATE WHICH WILL NOT BREAK OR BEND

BY GEORGE W. HAWLEY, M.D., WESTPORT, CONNECTICUT, AND
RALPH D. PADULA, M.D., NORWALK, CONNECTICUT

The occasional accident of bent or broken plates, in the hands of experts in the large medical centers, caused the Fracture Committee of the American College of Surgeons to appoint, a few years ago, a special committee to find ways and means to reduce this hazard. For the past ten years the senior writer has been working on a bone plate which will not bend or break and yet is technically easy of application and removal, should removal at any time be desired. At the same time, the effort has also been made to obtain unusually strong fixation of the plate to the bone.

The plate shown in Figures 1, 2, and 3 appears to meet these requirements. It has been tested for tensile strength on human dried bones and cadavera. It has been used in two cases of fracture of the shaft of the humerus, in two cases of fracture of the tibia, and in one case of fracture of the femur. As there is no essential difference between this plate and the Sherman plate from a clinical point of view, the case reports are omitted. In each case early callus has been observed in the roentgenograms, and no loosening of the screws has been noted. We have no idea what future experience may prove,—whether the screws eventually will become loose, and, if so, how early. As yet we have not removed a plate.

There is little technical difference in the application of this plate and the Sherman plate. The junior writer, who has carried out the experimental operative work on cadavera and dogs, has found a method of application which makes the operation somewhat easier and quicker than applying a Sherman plate.

The plate is an angle iron made of stainless steel, and is fairly thin, light, and compact. There is one size of plate for the femur and the tibia (weight-bearing bones), one for the tibia and the humerus, one for the humerus, and one for the radius and the ulna. Long screws are used so that they pass completely through the bone and extend about one-fourth of an inch. This is to ensure good threading and to hold in the distal cortex. The plate is applied from the side of the bone, so that the screw ends are visible. The ends of the screws are cut off flush with the bone by means of a jeweler's wire saw. With this small instrument, a notch is cut on the side of the screw which breaks off by bending. The burred screw end makes it more difficult for the screw to pull out, but does not hinder removal.

Two drill points are used. One is for the cortex distal to the plate and has been carefully selected, so that it is neither too small nor too large. If the drill point is too small, it is difficult to insert the screw without breaking its head. If the point is too large, the screw does not get a secure hold on the bone. Screws act to thread the hard bone and must obtain a firm hold. The other and larger drill is for the cortex proximal to the plate. This drill makes a hole slightly larger than the screw.

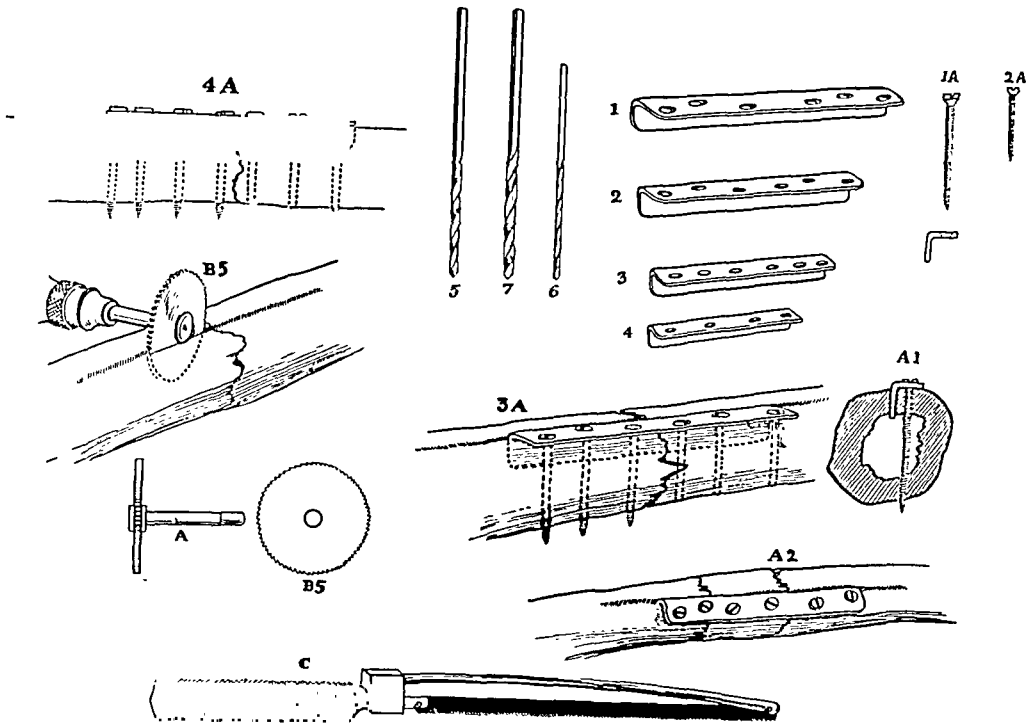



FIG. 1

Showing sizes of plates:

*1:* Plate for femur and tibia, four inches long, with flanges three-eighths of an inch wide and one-sixteenth of an inch thick.
*2:* Plate for tibia and humerus.
*3:* Plate for humerus.
*4:* Plate for radius and ulna, two inches long, one-quarter of an inch wide, and three-sixty-fourths of an inch thick.
*5, 6,* and *7:* Drills used: gage 34, 35, and 28.
*1A:* Screws for large plates: one and one-quarter inches, one and one-half inches, and one and three-quarter inches by one-eighth of an inch in diameter.
*2A:* Screws for small plate: one-half an inch and five-eighths of an inch by five-sixty-fourths of an inch.
*A:* Circular saw, one-sixteenth of an inch wide.
*B5:* One way of cutting slot for plate, given up for method described in text.
*C:* Jeweler's saw for cutting notch in ends of screws, so that the ends break off easily.
*A1:* Cross-section of plate and bone.
*A2:* Lateral view of plate attached to bone.
*3A* and *4A:* Diagrammatic views of plate, showing some screws cut off.

Our experiments show that six screws are advisable for the weight-bearing bones (the tibia and the femur). For the non-weight-bearing bones, we believe that four screws—two in each fragment—are sufficient.

The junior writer has arrived at the following technique after experimenting on cadavera and dogs and after operations on patients:

An incision is made to expose the bone on its outer surface. Exposure is free and adequate. In fractures of the tibia and the femur, the leg is put in traction on a fracture table to stabilize the limb and to reduce partly overriding and deformity. The bone ends are fully freed from the soft parts. No attempt is made to approximate the ends at this point, except to align and to mark each fragment with a sharp instrument for the longitudinal saw cut. One bone end is then lifted out of the wound, and a slot is cut with a motor saw. The blade of the saw is of the same thick-

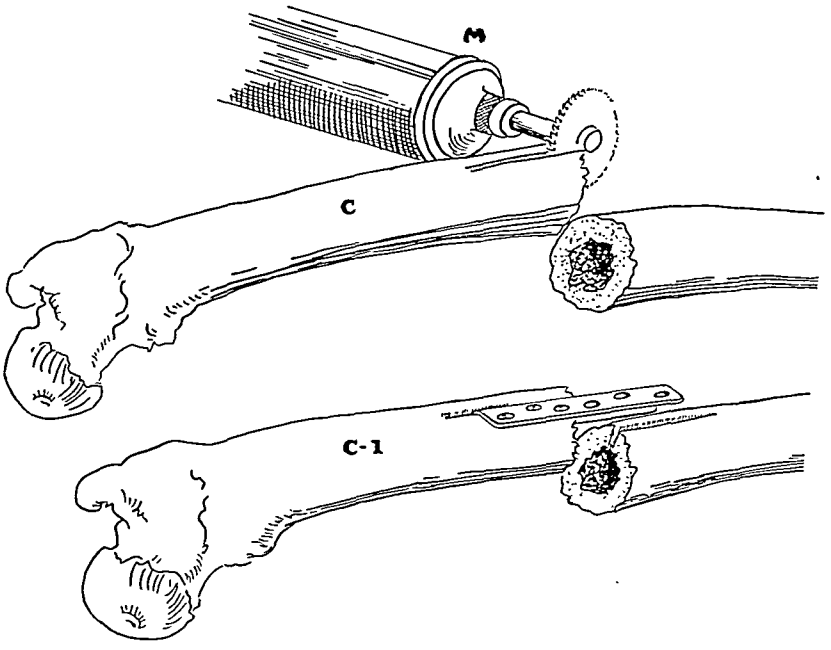



FIG. 2

*M:* Albee saw with saw blade one-sixteenth of an inch thick.
*C:* Bone end elevated for cutting slot.
*C-1:* Plate fastened to one bone end ready to fit into cut in opposite bone end.

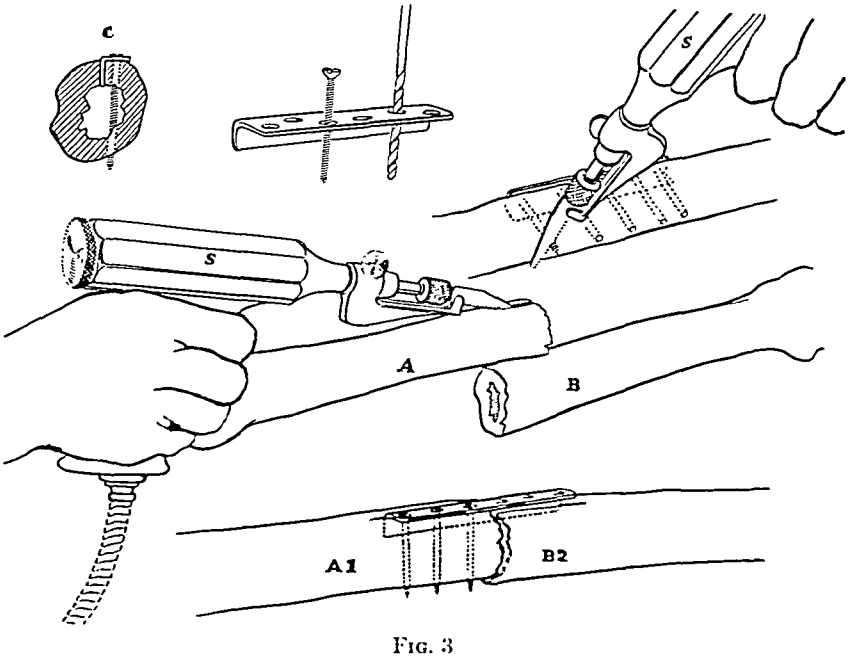



FIG. 3

*S:* Cayo saw cutting slot in one bone end and cutting off ends of screws with hack-saw blade.
*A-1* and *B-2:* Fitting plate into slot to complete reduction.



FIG. 7-A
Case 7. After operation.

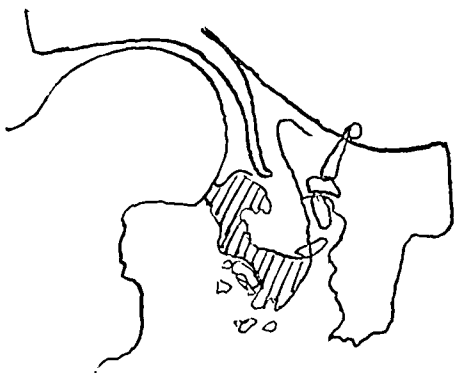


FIG. 7-B
Case 7. After operation.

of a man who, after having received a trauma to the left hip at the age of twenty-eight, had pain periodically over the left tuber ischii. He had been operated on repeatedly. No pathological-anatomical examination, however, had been performed. When the patient was examined at the Coast Sanatorium, the Pirquet reaction proved positive. The Wassermann and Kahn reactions were negative. Probably this is also a case of tuberculous osteitis. This opinion is strengthened by the fact that the patient, as a child, had a definite tuberculous infection (exudative pleurisy). Case 11 is an example of a chronic septic osteitis of the ischium. In most cases it is probably impossible to distinguish a tuberculous osteitis of the ischium from a septic one by mere roentgenographic examination. Nevertheless, the septic osteitis in these cases seems to leave a more sclerotic bone delineation and sharper outlines of the destruction than does the tuberculous osteitis.

Of the eight patients with certain tuberculous osteitis, one was treated conservatively (on account of a very advanced pulmonary phthisis), and the others were operated on. In three of the latter cases (Cases 2, 4, and 6), only sequestrectomy was carried out. In two of the four remaining cases (Cases 3 and 5), gouging, scraping out, and sequestrectomy (Case 3) were performed; in the other two cases (Cases 7 and 8), subperiosteal resection of the tuber ischii

# TYPHOID SPINE

BY H. A. SWART, M.D., F.A.C.S., CHARLESTON, WEST VIRGINIA

Typhoid involvement of the spine has never been common; according to Gall, the incidence is one case in every 1800 cases of typhoid fever. In recent years, due to better milk and water supplies, it has become quite rare. The following case is interesting in that the patient was under observation from the time of onset of the typhoid fever, through the period of active involvement of the spine, until apparent cure was effected.

## CASE REPORT

A. P., white male, aged nineteen, unmarried, was admitted to the Charleston General Hospital on February 22, 1936, with the history of having suffered from chills, fever, delirium, and diarrhoea for two weeks. On admission his temperature was 104.4 degrees, and the pulse rate was 120. Physical examination revealed the presence of herpes, congestion of the pharynx, and a markedly distended abdomen. The blood count showed 4,100,000 erythrocytes, and 10,100 leukocytes, with hemoglobin of 91 per cent. The Widal blood test was reported positive by bacillus typhosus in a dilution of 1:500. The disease ran a stormy course with marked delirium and fever up to 105 degrees for two weeks. He was given intravenous fluids and blood transfusions, following which his temperature subsided. He was allowed to go home on March 22, 1936, after having been in the hospital one month.

The patient returned to the hospital on April 23, 1936, with the complaint of low-back pain, accompanied by fever, which he had had for one week. His local physician had found pus in the urine. On the day of admission he had had a chill. Examination at this time revealed tenderness and muscle rigidity of the right lumbar region. His temperature was 103.6 degrees. Analysis of the urine showed a definite amount of pus,—2 plus on a basis of 4. Reexamination of the blood disclosed nothing significant. A test for undulant fever was negative. Roentgenographic examinations of the chest and abdomen were negative, except for the finding of scoliosis of the lumbar spine to the left. A retrograde pyelogram was made on May 4, 1936, and nothing was shown except the scoliosis to the left as before. A roentgenogram on May 20, 1936, showed only scoliosis of the lumbar spine. A diagnosis of pyelitis was made and the patient was put on a ketogenic diet. His temperature fluctuated in an irregular manner, but gradually came down to normal at the end of three weeks. The pain gradually became less and at the end of sixty days, on June 26, he was again dismissed from the hospital.

The patient was readmitted to the hospital on August 1, 1936, at which time he was first seen by the author. He complained of a severe aching in the right lumbar region. He also stated that the right leg was shorter than the left, and that the left leg was weak, forcing him to use crutches to get about. Examination revealed a total curve to the left in the lumbar area. There was no particular tenderness of the spine or adjacent muscles. Motions of the spine produced pain in the right hip. There was marked weakness of the muscles of the left leg with absence of the knee jerk on that side. The ankle jerk, however, was present. In the right leg all reflexes were active. There was atrophy of the left thigh, amounting to two centimeters, but none in the calf. The spinal fluid was examined and found to be negative. Urinalysis was negative and blood studies were again not significant.

A roentgenogram of the lumbar spine (Figs. 1-A and 1-B) revealed a destructive process between the second and third lumbar vertebrae with involvement of the disc and scoliosis to the left as before. The temperature at this time was normal. A diagnosis of

ness as the plate. While the bone end is raised, one-half of the plate is inserted into the slot and the bone is drilled,—first, the distal cortex with the smaller drill; then, the proximal cortex with the larger drill. The screws are then inserted and the ends are cut off.

The other bone end is raised out of the wound, and a saw cut is made in the line already marked. The fragments are then approximated, and the plate is slipped into the bed which has been prepared for it. The ends are then impacted one against the other by pressure in the long axis of the bone. The final screws are inserted and the ends are cut off. The wound is closed, and dressings and a cast are applied.

We wish it to be understood that we do not advocate the operative treatment of fractures, except in certain cases in which operation seems justified. On the contrary, we believe that plating operations should be left to those with adequate training and instrumental equipment. We simply offer this plate as a substitute for the Sherman plate, solely by reason of the fact that it will not break or bend.

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Since the above was written, we have been using plates made of vitallium, an alloy which does not contain iron and which resists corrosion.

The scientific and painstaking experiments carried out by Dr. C. S. Venable on the electrolysis induced by different metals buried in living tissue show that vitallium is devoid of electrolytic action, and so-called "eighteen and eight" stainless steel (18 per cent. chromium and 8 per cent. nickel) has very little. Both are highly resistant to corrosion. At the present time we are inclined to believe that there is little choice between the two, but in this we may be mistaken.

The plate which we have described was informally presented at the Annual Meeting of the Fracture Committee of the American College of Surgeons in New York, on February 18, 1938. The question of cutting the slot was raised. In our experimental operations we expected to encounter some difficulty, but in practice the cutting of the slot and the fitting of the plate proved quite easy. One difficulty is, however, quite obvious. This is the use of penetrating screws which have to be cut off. Our experiments indicate that this provides the strongest anchorage of the plate. It may be that this is not necessary, that screws which just penetrate the full diameter of the bone are sufficient. It is not difficult to select such screws by measuring the diameter of the bone at operation. Such screws are advised when a plate is applied on the anterior surface of a bone and not from the side, so that the screws are visible. A plate may be applied with screws which only penetrate the cortex next to the plate, but the hold of the plate depends on the screws, and our tests show that, under strain, such screws will pull loose.

Weakness in the screw, near the head, is the only structural defect which we have encountered. Not often, but occasionally, the head of a screw has broken off at operation. With more careful introduction this would probably not occur.

Mercer and Jones and Lovett state that such a condition is osteomyelitic in character, but in the present case the process appeared to be an osteitis rather than an osteomyelitis, as there was at no time any evidence of abscess formation.

This case shows that, in addition to involvement of the vertebrae in typhoid spine, the nerve roots may also be affected. Mercer states that frequently tenderness along the sciatic nerve, hyperaesthesia of the lumbosacral region, and sometimes anaesthesia of certain parts of the hip and the leg are noted. He also points out that the reflexes are usually increased. In this case the knee jerk on the left side was abolished at one time, and there were no sensory changes.

According to Mercer, the roentgenographic changes show broadening of the intervertebral discs with deposits of bone on the lateral aspects of the affected vertebrae. Our roentgenograms, however, showed destruction of the intervertebral discs and the adjacent borders of the vertebral bodies.

Whitman states that the symptoms usually last six months, and that the outlook is good. In our case, we allowed the patient to go without support at the end of eight months, and he was apparently completely well in one year. It is felt that recovery in this case was expe-



FIG. 2-A

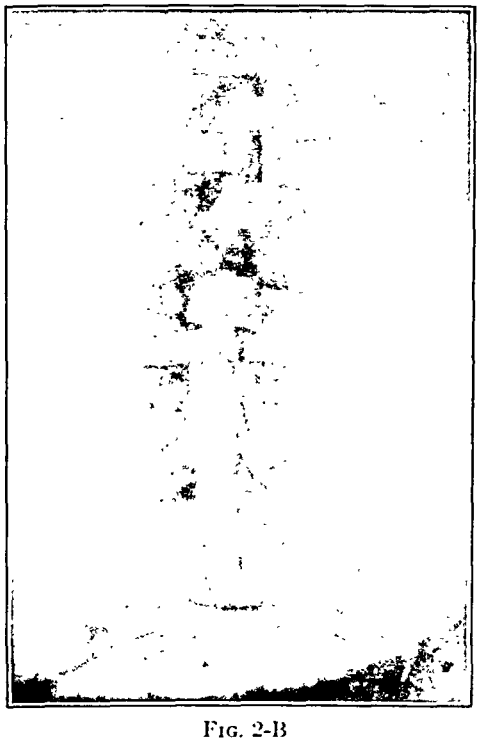


FIG. 2-B

Lateral and anteroposterior roentgenograms of the lumbar spine, showing loss of the disc between the second and third lumbar vertebrae with evidence of healing of the lesion.

typhoid spine was made, and the patient was placed on a hyperextension frame with ten pounds of traction by Buck's extension on each leg. This was left on thirty days, and some improvement of the scoliosis was noted. A hyperextension cast was then applied from the upper chest to the knee on the right, and twelve days later the patient was allowed to go home wearing the cast.

He remained comfortable in the cast, and at the end of three months it was removed. At this time the patient stood tilted slightly to the right, and a roentgenogram showed almost entire disappearance of the disc between the second and third lumbar vertebrae. A Taylor brace was obtained for him, which he wore regularly for four months. Then he was allowed to leave it off one hour per day and this was gradually increased until the brace was discarded.

On June 1, 1937, ten months after the diagnosis was made, motions of the spine were found to be good and painless. There was a slight curve to the left in the lumbar region, but his back gave him no trouble.

On July 19, 1937, the patient came to the hospital for permission to go to work. The mild scoliotic curve to the left was still present, but all motions were completely painless. A roentgenogram at this time (Figs. 2-A and 2-B) showed loss of the disc between the second and third lumbar vertebrae with evidence of healing of the lesion and scoliosis with convexity to the left.

On August 5, 1937, the patient was again seen. He stated that he had worked eight days and had then stopped because he did not like his work, not because of pain in his back. Examination at this time revealed what seemed to be a normal spine with the exception of the slight curve. The left knee jerk had reappeared, and the circumference of the thighs was the same.



FIG. 1-A

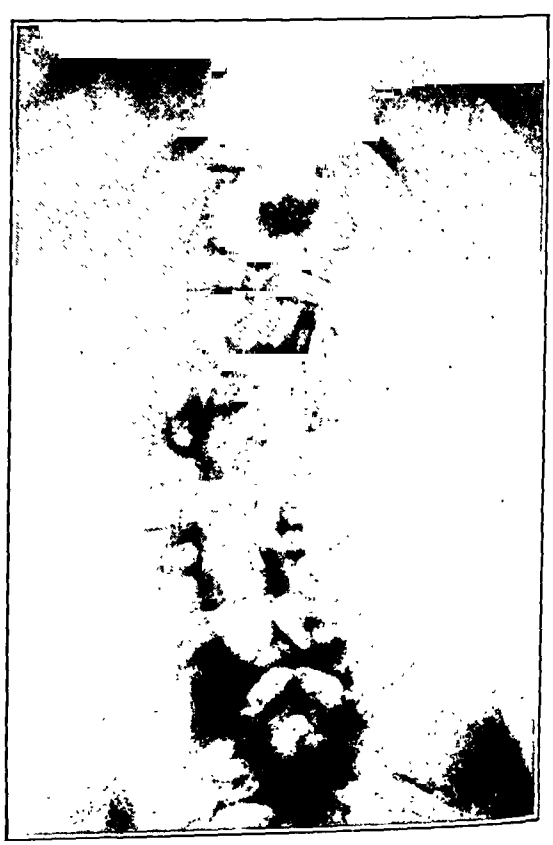


FIG. 1-B

Lateral and anteroposterior roentgenograms of the lumbar spine, showing a destructive process between the second and third lumbar vertebrae with involvement of the disc and left scoliosis.

# BILATERAL UNDESCENDED SCAPULA WITH OMOVERTEBRAL BONE

BY PARKER C. CARSON, M.D., SPRINGFIELD, MASSACHUSETTS

*From the Shriners' Hospital for Crippled Children, Springfield*

Congenital elevation of the scapula with omovertebral bones is an uncommon congenital anomaly. In 1908 Horwitz reviewed the literature and found twenty-seven cases. Shore surgically removed a unilateral omovertebral bone, and Jackson reported a similar case, describing the condition as being costal in origin and attached to the scapula by cartilage. Jackson's contention that the term "congenital elevation of the scapula" is a misnomer appears quite sound, since, as he points out, embryologically the condition represents failure of the bone to descend. Bilateral occurrence of the condition appears to be exceedingly rare, and the following case is presented for this reason.

## CASE REPORT

A twelve-year-old girl was admitted to the Shriners' Hospital for treatment of a bilateral deformity of the shoulders, a left club foot, and bilateral hallux valgus; all of these conditions had been present since birth. The past history and family history were not significant.

### *Physical Examination*

The general examination showed a well-nourished adolescent girl in good health. Orthopaedic examination revealed a short, thick neck with no limitation of movements. (See Figure 1.) The right scapula was high with a very prominent acromion process anteriorly. The superior border was at about the level of the fifth cervical vertebra, and the inferior angle was at the level of the fifth rib. The scapula was slightly movable. It measured five and one-half inches from the superior border to the inferior angle and seven inches from the acromion process to the medial angle. No definite omovertebral bone was palpated. The right clavicle was markedly angulated anteriorly in its distal third. The left scapula was immobile and firmly attached at about the seventh cervical vertebra. A definite process was palpated from the medial angle to the spinous process. The superior border was somewhat lower than the right with a less prominent acromion process. The scapula measured five inches from the superior border to the inferior angle. A definite medial angle was not palpated. The inferior angle was at the fourth rib. A definite scoliosis to the right, centering at the tenth thoracic vertebra, with moderate rotation was present. The lumbosacral articulation was rigid. The superior extremities were normal with the exception of limitation of abduction and circumduction at the shoulder joints above the level of the joints. The inferior extremities were normal except for an equinovarus of the left foot with a marked cavus. The left ankle joint was rigid in equinus at 110 degrees. Bilateral hallux valgus was present. Neurological examination was essentially normal.

### *Preoperative Roentgenographic Examination*

An anteroposterior roentgenogram of both shoulders (Fig. 2), including the lower cervical spine, showed long transverse processes of the sixth cervical vertebra with spina bifida of the fifth, sixth, and seventh cervical vertebrae. These processes articulated

dited by traction in hyperextension on a convex frame, and by the continuation of the hyperextension by the cast and the brace.

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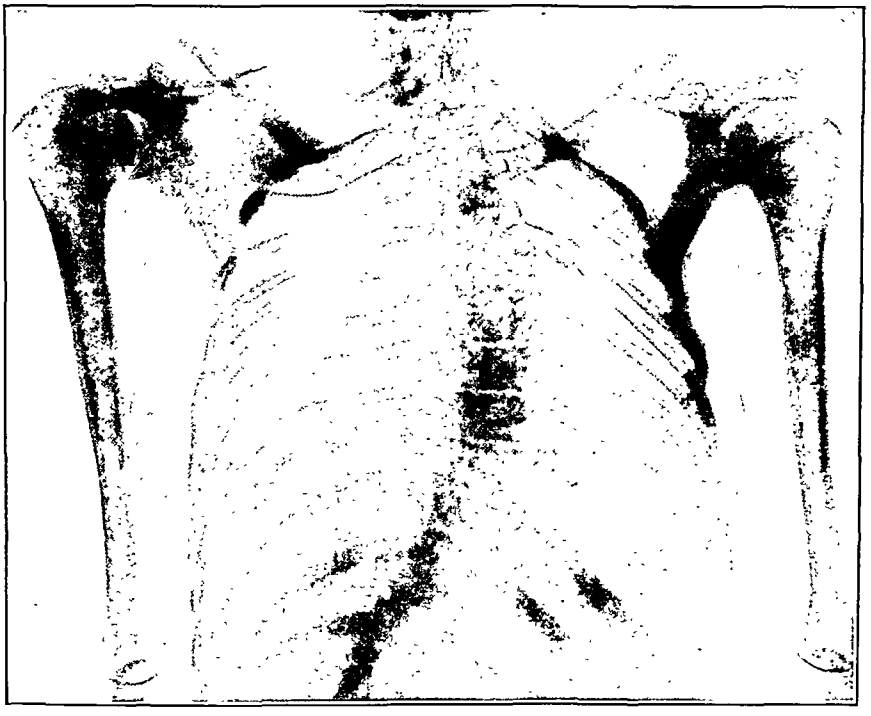


FIG. 2

Preoperative roentgenogram, showing long transverse processes of the sixth cervical vertebra with spina bifida of the fifth, sixth, and seventh cervical vertebrae. The processes articulate with the medial margins of both scapulae.



FIG. 3

Postoperative roentgenogram, showing complete removal of the bone which articulated with the scapulae and a slight scoliosis of the cervical spine to the left.

with the medial margins of both scapulae; this was most marked on the left, where the articulation closely resembled a sacro-iliac joint.

An oblique roentgenogram of the shoulders and scapula failed to show on the right any articulation between the transverse process of the scapula; on the left, however, there was a definite articulation, slightly wider than a sacro-iliac articulation, but otherwise very similar to it.

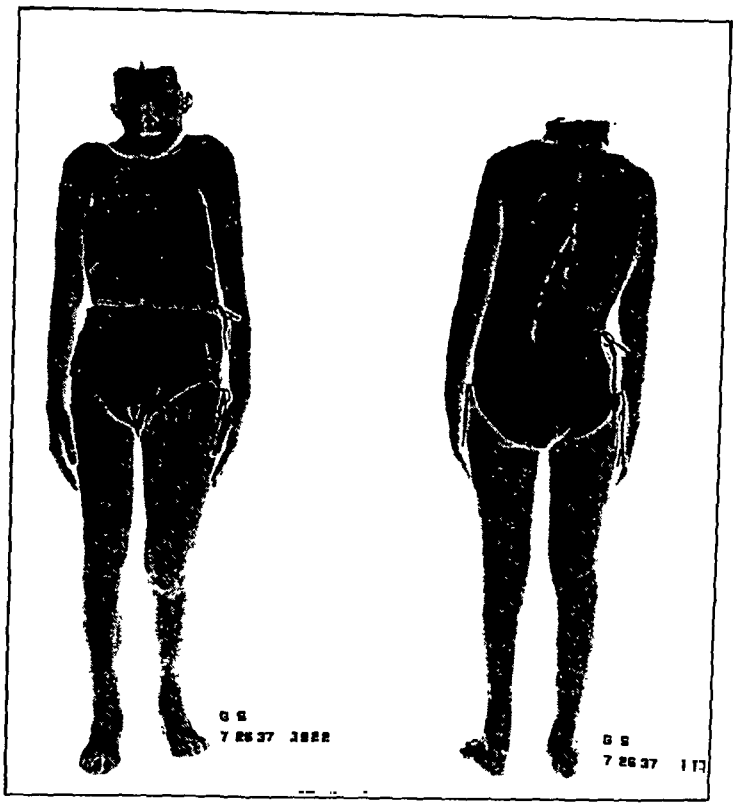


FIG. 1

Patient before operation.

An anteroposterior roentgenogram of the thoracic spine revealed scoliosis of the mid-thoracic spine four centimeters to the right.

An anteroposterior roentgenogram of the lumbar spine and pelvis disclosed sacralization of the transverse process of the fifth lumbar vertebra on the right.

Anteroposterior and lateral roentgenograms showed rather marked hallux valgus of both feet, pes cavus of the left foot, and pes planus of the right foot, but the bones of the right foot appeared normal.

*Operation*

An operation for resection of the anomalous bony process between the scapula and the sixth cervical vertebra was done. A transverse incision was made beginning at the spine of the left scapula; this was carried to the spinous process of the seventh cervical vertebra and over and across to the spine of the right scapula. The base of the spine of the scapula and the adjacent body of the bone were exposed by subperiosteal dissection, disclosing immediately the anomalous process; this was attached to the medial angle throughout its length by a cartilaginous plate which showed no evidence of joint formation. The process measured approximately two and one-half inches at its attachment to the scapula; it tapered down to about three-fourths of an inch in size and was attached to, or a part of, the transverse process of the sixth cervical vertebra. The scapular end of the bone was freed by cutting through the cartilaginous layer; then subperiosteal dissection was carried down to the vertebral origin of this process, where it was removed near the vertebra with a Gigli saw. Small remaining fragments were trimmed with bone cutters. When the bone was removed, the scapula showed relatively normal mobility. The dissection was then shifted to the right side where a similar procedure was carried out. The anomalous process on this side, approximately three inches in length, showed a pseudarthrosis with the scapula, the tip having a cartilaginous plate without a definite joint formation. The process on this side more nearly resembled a rib and, at its vertebral end, there was a constriction similar to the neck of the rib and an irregular faceted articular end. The direct attachment of this end to the vertebra was not examined, since the direct exposure would require a considerable amount of dissecting which appeared to be unnecessary. The bone was removed subperiosteally. The scapula on this side, however, did not show the marked increased




FIG. 8
Case 9

and the adjoining parts of the superior ramus was done. In the latter two cases, the operation was performed under lumbar anaesthesia, with the patient lying in a prone position. The other operations were carried out under ether narcosis. Of the cases of osteitis of unspecific or uncertain origin, two (Cases 10 and 11) were treated conservatively; sequestrectomy and gouging were done in two (Cases 9 and 12); and subperiosteal resection was carried out in the remaining one (Case 13).

In all of the cases operated on the wound was closed immediately. In five of the cases of certain tuberculous osteitis, fistulae were found at the operation. In some of the cases, fistulae appeared shortly after the operation or later on in the operative cicatrix, and in a few cases it was necessary to perform a second operation (sequestrectomy). At their discharge from the hospital all of the patients except two (Cases 1 and 2) were healed. According to the information received from these patients, they have remained healed and otherwise free from symptoms. Milch has recently given an account of the technique used in operations on the ischium. At the gouging and resection in the cases described in this paper great stress was laid on maintaining the periosteum intact as far as possible, in order to secure the circulation from without and thus lessen the chances of the occurrence of new sequestra. The periosteum is cut

mobility that was found on the left, and posterior displacement of the scapulae was probably inhibited by the clavicles.

*Postoperative Roentgenographic Examination*

A postoperative roentgenogram of both shoulders and cervical spine (Fig. 3) revealed complete removal of the bone which articulated with the scapulae. The cervical spine showed a slight scoliosis to the left.

*End Result*

The postoperative course was uneventful. Both scapulae are freely movable. The left is well displaced backward with the inferior angle at the fifth rib. The position of the right is unchanged. Functionally, the patient can raise both arms well above the level of the shoulder joints, with better results on the left.

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# PREGNANCY COMPLICATED BY OSTEOPETROSIS

## Report of a Case

BY HARLEY E. ANDERSON, M.D., OMAHA, NEBRASKA

*From the Department of Obstetrics, Immanuel Hospital, Omaha*

Osteopetrosis, a fairly rare condition, sometimes called osteosclerosis fragilis or marble bones, was first described by Albers-Schönberg in 1904. By the end of 1936 some eighty-three cases had been reported.

As the name "marble bones" implies, the bones of the entire skeleton become very hard, with replacement of the spongiosa by compact tissue, and with extraordinary increase in the calcium content. The most common symptoms are spontaneous fracture and anaemia; the next common are hydrocephalus and blindness.

A review of the cases of osteopetrosis shows the greatest percentage occurring in children, some *in utero;* also a larger number of females than males. The consensus of opinion is that this disease is a hereditary, familial, and constitutional one; the etiology is unknown, although several theories have been advanced. Careful perusal of the literature revealed no case complicated by pregnancy. For this reason, and because of its interest, the following case is reported.

### CASE REPORT

Mrs. W. C., secundigravida, primipara, aged twenty-six, was seen on August 4, 1936, complaining of weakness. exhaustion, and an amenorrhoea of two months' duration.

The history of the patient disclosed a pregnancy four years previously, complicated by exhaustion and weakness, and delivery of a full-term female child after a rather long labor. One and a half years later a "run-down" condition was diagnosed as anaemia. A persistent cough seemed to indicate some lung pathology. Roentgenographic examination, however, disclosed no lung pathology, but a very curious pathology in the bones comprising the thoracic cage. A complete study of all the bones of the body revealed a generalized osteopetrosis.



FIG. 1

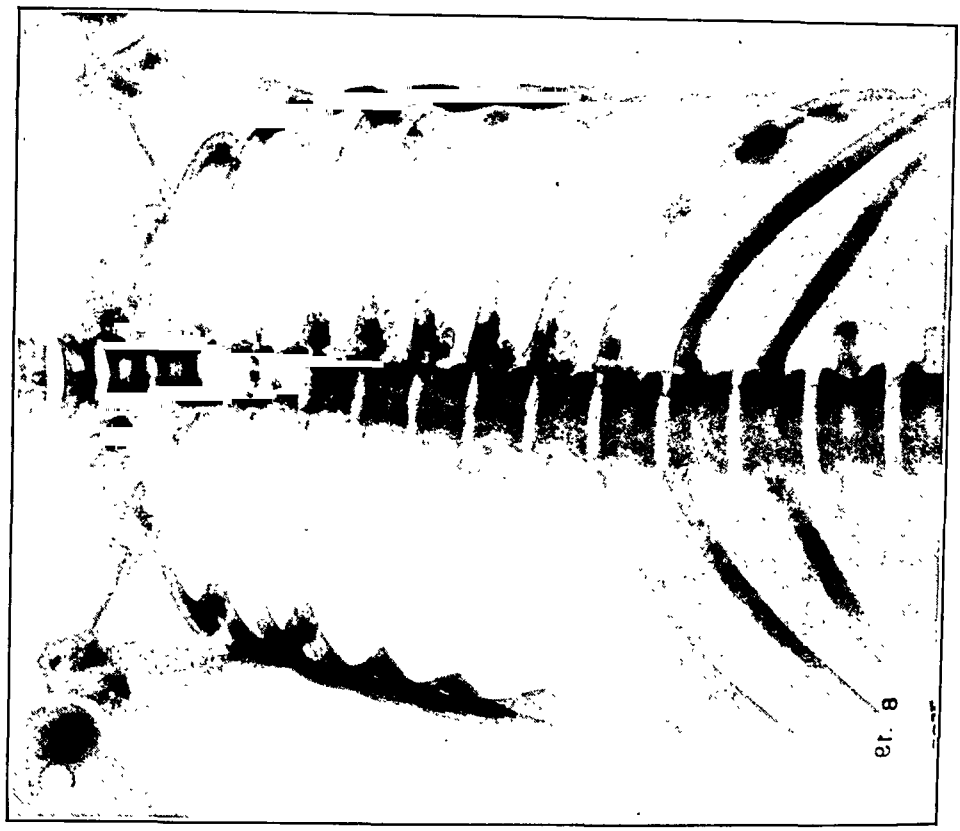


FIG. 3

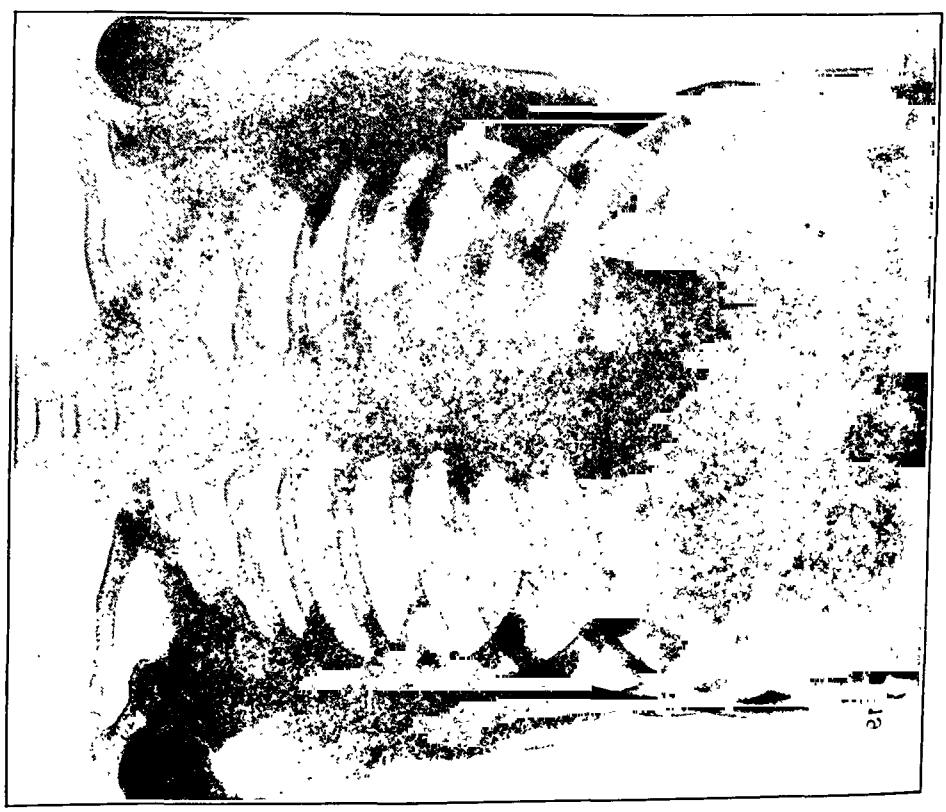


FIG. 2



FIG. 6

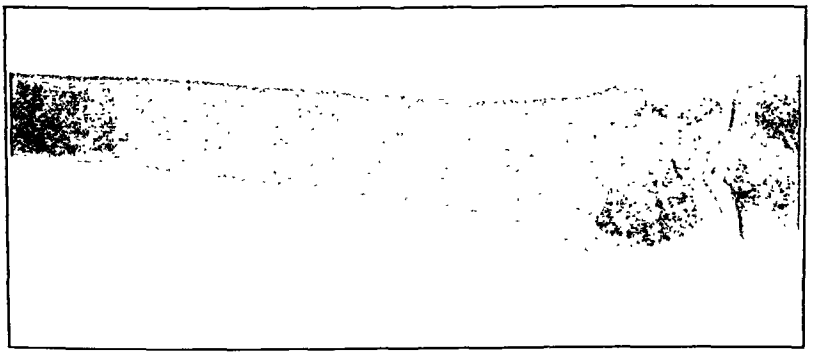


FIG. 5

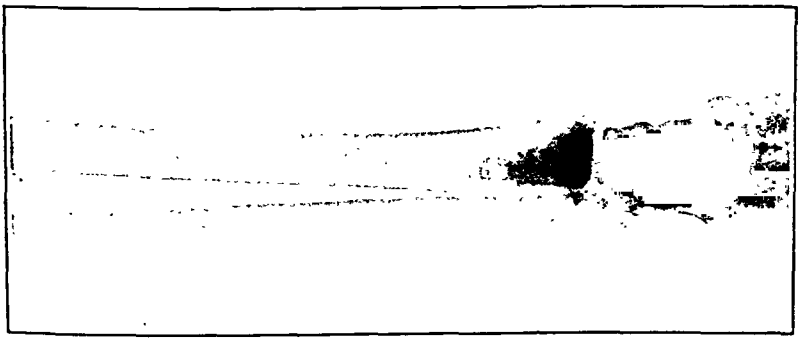


FIG. 1

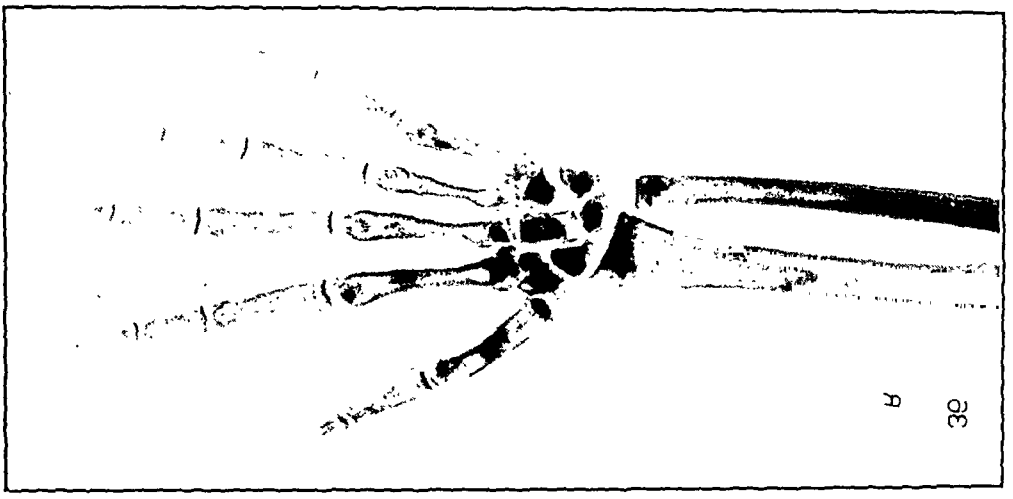


FIG. 7

The patient's familial history was not remarkable. Her father was living and well; her mother died in the early thirties from a heart and kidney disease.

From the time of diagnosis of osteopetrosis until the patient first consulted the author, she had had a number of recurrences of anaemia, which required both intravenous and intramuscular medication as well as oral medication.

On examination, the patient's skin was rather pale; the size of the head seemed larger than normal. There were a few cervical glands palpable just anterior to the sternomastoid muscle. Examinations of the thorax, the heart, and the abdomen were all negative. Pelvic examination revealed the cervix lacerated slightly and to the left, soft, with the typical bluish discoloration of pregnancy. The corpus uteri was markedly retroverted and soft, and was estimated to be about the size normally found after two months of pregnancy. The blood pressure was 98/62.

Laboratory findings showed:

Red blood cells—5,260,000
Hemoglobin—80 per cent.
Color index—.7; mean corpuscular hemoglobin—25 micromicrograms
Mean corpuscular volume—76 cubic microns

White blood cells—12,600
Polymorphonuclear neutrophiles—65 per cent.
Large lymphocytes— 2 per cent.
Small lymphocytes— 32 per cent.
Eosinophiles— 1 per cent.

Coagulation time—2½ minutes; bleeding time—1 minute

Blood phosphates—3.34 milligrams in 100 cubic centimeters of blood; blood calcium—8.8 milligrams in 100 cubic centimeters of blood.

Uncatheterized specimens of urine showed a trace of albumin and a few red blood cells and pus cells.

Roentgenographic studies showed a uniform increase in density of the bones of the skull, with obliteration of the medullary spaces, and a loss of clarity of the suture lines. No mastoid cells appeared; both anterior and posterior clinoid processes were very dense, with no bridging (Fig. 1). The ribs (Fig. 2), all the bodies of the spine (Fig. 3) and long bones (Figs. 4 and 5), and the bones of the pelvis (Fig. 6) showed a homogeneous increase in density throughout, with loss of all detail and obliteration of the medullary spaces. The metacarpals, and to a lesser degree the phalanges (Fig. 7), were beginning to show some of the changes. The diagnosis was osteopetrosis.

Inasmuch as this condition is a familial, hereditary disease, observers are agreed that pregnancy is contra-indicated. For this reason, a hysterotomy was done with removal of the foetus and sac intact. Sterilization by resection and ligation of the fallopian tubes, a

suspension of the uterus, and an appendectomy were done. The patient made an uneventful recovery and has since left the city.

At the University of Nebraska College of Medicine, microscopic sections of the foetus were made, but it was too small to show any important osteogenetic changes.

## DISCUSSION

The consensus of opinion is that osteopetrosis is a hereditary, familial disease, the course of which is chronic, progressive, and unresponsive to treatment.

Pregnancy is contra-indicated; termination of pregnancy and sterilization are, therefore, advisable.

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# TRAUMATIC MALACIA OF CARPAL BONES

## A Case Report

BY C. W. BRAINARD, M.D., BATTLE CREEK, MICHIGAN

Repeated trauma may result in alterations in the carpal bones which simulate the clinical changes in the forefoot in the so-called "march foot". Köhler has given a lucid description of the roentgenographic changes present in the lunate, occasioned by occupational compression injuries. This was first described by Kienböck in 1910, and is designated traumatic malacia, or Kienböck's disease.

### CASE REPORT

O. M., white, male, aged twenty-eight years, a mill worker, was seen on August 13, 1934. He stated that five days prior to examination he had noticed a painful swollen left wrist. There was no history of accident, and his general health was excellent. The usual home treatment had been instituted with no success, and increasing pain and swelling caused him to seek medical advice.

Questioning brought out the fact that the patient's occupation consisted of keeping the flow of corn through a pipe in the floor of a bin from interruption by clogging. This was done with a metal bar, tamping the kernels through the opening of the pipe, the impact of the blow being at the base of the palm, and was estimated by the patient to be as




FIG. 1

Roentgenogram showing loss of contour of the carpometacarpal articulations of the lesser multangular, the capitate, and the hamate, and a decalcification of the distal borders of the carpals and the proximal ends of the metacarpals.

frequent as twenty times an hour. This occupation had been followed for two years before the onset of symptoms.

Examination was essentially negative except for the left wrist which was swollen and tense, more particularly on the dorsum, with no evident redness or heat. Motion was limited and painful, particularly in palmar flexion. Palpation elicited extreme pain on both dorsal and palmar surfaces with no evident localization.

Roentgenographic examination (Fig. 1) showed a loss of the contour of the carpometacarpal articulations of the lesser multangular, the capitate, and the hamate, and a decalcification of the distal borders of the carpals and the proximal ends of the metacarpals. In comparison with roentgenograms of the right wrist, those of the left wrist showed an osteoporosis of all of the carpal bones, particularly the navicular which showed a small area of cystic degeneration on its mesial border.

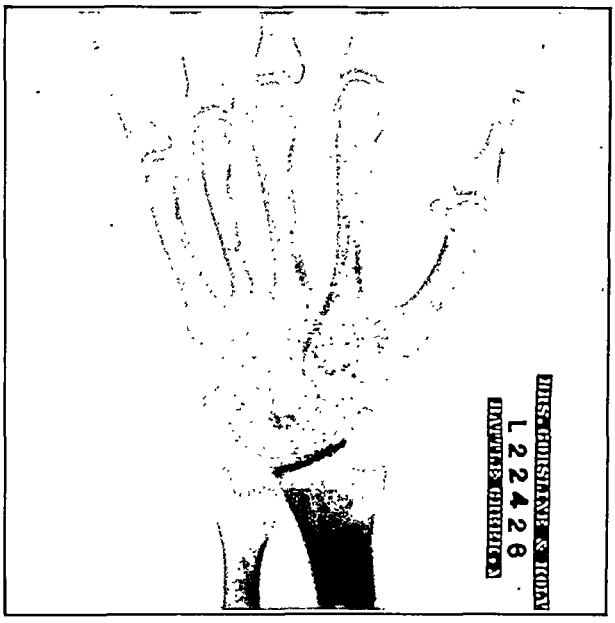



FIG. 2

Roentgenogram showing complete restoration of the joint surfaces. The decalcification process has been arrested and bony trabeculations are evident throughout the bodies.

Treatment consisted of immobilization in a circular cast with the wrist in the cock-up position. The swelling and pain disappeared in a relatively short time, and in six weeks a cock-up splint was applied. Improvement was gradual, pain in palmar flexion being the last symptom noted, and, on December 3, a further roentgenographic study (Fig. 2) was made, which showed a complete restoration of the joint surfaces. The decalcification process was arrested and bony trabeculations were evident throughout the bodies. The cystic degeneration of the navicular was not in evidence, and complete restoration of the bony contour was noted.

The patient returned to his former occupation with directions as to the proper use of his hand and wrist, and has had no return of symptoms.

This condition can well be due to compression injuries, producing a disturbed nutrition of bone similar to the repeated trauma of inordinate weight-bearing which is thought to cause the painful swelling of the forefoot in the so-called "march foot", with its attendant bone changes in the metatarsals. In this case immobilization was sufficient to effect relief of symptoms, and the roentgenographic appearance was such as to warrant an optimistic viewpoint as to the ultimate complete recovery.

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# MULTIPLE CONGENITAL DISLOCATION

BY M. KAMEL HUSSEIN, F.R.C.S. (ENG.), M.CH.(ORTH.),
CAIRO, EGYPT

*From Kasr-El-Aini Hospital*

Congenital dislocations are extremely rare in Egypt. During the course of several years a large hospital may admit only one or two patients with congenital dislocation of the hip. As often happens when a disease is rare in a locality, the cases encountered are often of the severer types. Among the very few cases seen, the majority were bilateral, and congenital dislocations of both knees were as common as those of both hips: whereas in other countries the former lesion is extremely rare as compared with the latter. The rare types of congenital dislocations occur about as frequently as in other countries. No explanation is forthcoming.

The following case is sufficiently unusual to warrant its being reported.

The patient, a girl, was seen about a week after birth. There was nothing abnormal in the delivery and a previous child was perfectly healthy. No other members of the family had ever had any similar trouble. Roentgenographic examination (Figs. 1 and 2) showed dislocation of the hips, the knees, the tibiofibular joints, the elbows, the radio-ulnar joints (proximal and distal), and the shoulders. Correction of the knees was started at once, with definite improvement in a month. The patient died at about the age of three months and was reported to have had a very indefinite lump in the abdomen.



FIG. 1

Multiple congenital dislocations. Both hips, knees, and tibiofibular joints (proximal and distal) are dislocated.

Apart from its interest as a very rare condition, this case is such as to cause one to reconsider the etiology of congenital dislocations. Abnormal positions can hardly be expected to separate the

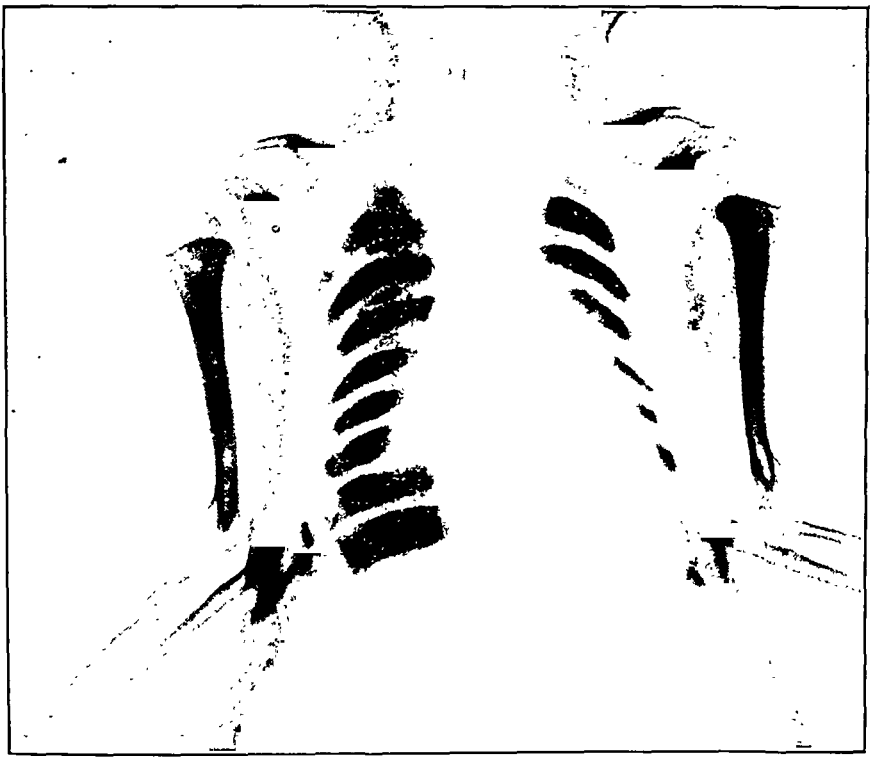


FIG. 2

Multiple congenital dislocations. Both shoulders and radio-ulnar joints (proximal and distal) are dislocated.

radio-ulnar and tibiofibular joints. It seems very likely that there is an inherent defect in the mesenchyme which causes such multiple and universal lesions.

# FRACTURE OR EVULSION OF THE ANTERIOR SUPERIOR SPINE OF THE ILIUM

BY E. N. CLEAVES, M.D., BOSTON, MASSACHUSETTS

Fracture or evulsion of the anterior superior spine of the ilium is not a very common occurrence. According to Dr. Voigt Mooney of Pittsburgh, there have been fifty-eight cases reported. Dr. Mooney added two more cases, bringing the total to sixty. The author wishes to report two cases which have come under his observation.

CASE 1. T. W., a well-developed, white boy, eighteen years of age, was playing touch football on November 14, 1935. He caught a pass and ran seventy-five yards, when he felt pain in the right groin. He had experienced similar pain before, and had called it "a muscle pull". The pain persisted for several days, and then completely disappeared. On November 22, he felt entirely well, and again played touch football. He received a kick-off and ran eighty yards to the goal line. Just at the goal line, he felt a "sudden crack" or "sense of something giving way" on the right side in the region of the anterior superior spine. His leg buckled under him and he fell, landing on the left hip. There was immediate marked pain in the right side of the pelvis and the right leg. The patient got up, walked around with a limp, but continued in the game for about twenty minutes, although he did not run. After taking a shower, the patient tried to go down some steps, and felt very acute pain. He then had to be carried to the infirmary, where he was placed in a plaster spica. He had an uneventful recovery in from six to ten weeks.

CASE 2. T. S., a well-developed, white boy, seventeen years of age, was injured by a sudden twisting motion, while playing football. There was no direct violence. Accom-



FIG. 1

*Case 1*



FIG. 2

Case 2

panying the twist, there was sudden, severe pain in front of the hip. The patient was able to walk, although with some degree of discomfort. Treatment consisted of the application of a figure-of-eight bandage; no plaster was used. An uneventful recovery followed.

These two cases are typical of this lesion. It usually occurs during adolescence, in boys or girls who are engaged in athletics. The patient experiences sudden severe pain in the region of the anterior superior spine of the ilium, following strenuous muscular effort or a sudden unguarded movement. The roentgenogram is quite typical. Complete recovery is the usual result.

| Case No. | Hospital No. | Sex | Age (*Years*) | *Localization* | Abscess | Fistula | Sequestrum | Treatment | Result at Discharge | Pathological Diagnosis | Follow-up Examination | Fig. No. | Other Localizations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 924/28 | Male | 34 | Left tuber ischii | None | Yes | None | Conservative | Not healed | | Healed | 1-A, 1-B | Pulmonary tuberculosis |
| 2 | 568/29 | Male | 26 | Left tuber ischii and superior ramus of the ischium | None | Yes | Yes | Sequestrectomy | Small fistula | | | 2-A, 2-B | Tuberculous lymphoma of the neck and tuberculosis of the right hip |
| 3 | 361/31 | Female | 20 | Superior ramus of the left ischium | None | None | Yes | Gouging and sequestrectomy | Healed | Tuberculosis | Healed. No symptoms from the hip joint | 3-A, 3-B, 4-A, 4-B | |
| 4 | 6/32 | Male | 6 | Right ischium | None | Yes | Yes | Sequestrectomy | Healed | | Healed. No symptoms from the hip joint | | Tuberculosis of the left knee with fistula |
| 5 | 537/32 | Female | 22 | Superior ramus of the left ischium | None | Yes | None | Excision of the fistula and gouging | Healed | Tuberculosis | Healed | 5-A, 5-B | |
| 6 | 433/33 | Male | 24 | Right tuber ischii | None | Yes | Yes | Sequestrectomy | Healed | Tuberculosis | Healed | | |
| 7 | 338/34 | Male | 53 | Right tuber ischii and superior ramus of the ischium | None | Yes | Yes | Partial subperiosteal resection of the superior ramus and half of the tuber ischii | Healed | | Healed | 6-A, 6-B, 7-A, 7-B | Tuberculosis of the right knee |
| 8 | 169/36 | Male | 35 | Left tuber ischii and superior ramus of the ischium | Yes | Yes | Yes | Partial subperiosteal resection of the tuber ischii and the superior ramus | Healed | Tuberculosis | Healed | | |

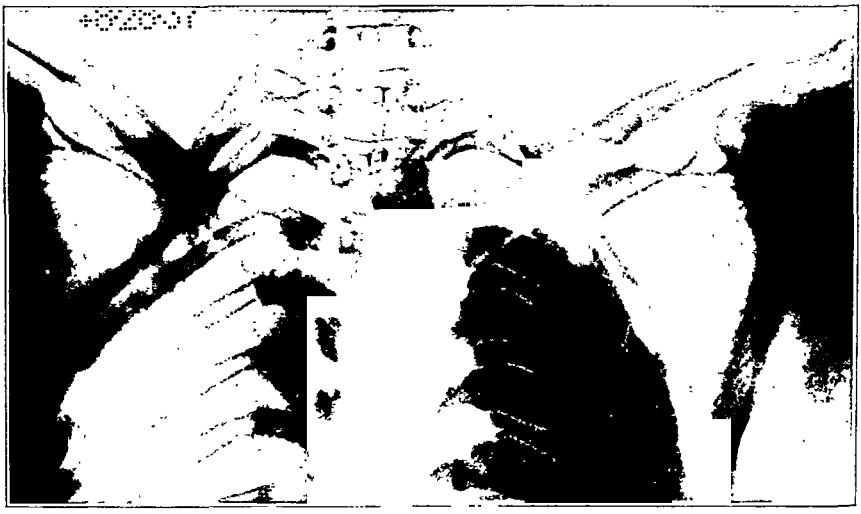


FIG. 1

W. R. Roentgenogram on admission, showing fractures of the first ribs without any alteration of alignment.

of the right side of the second thoracic vertebra was also recorded in the report of this roentgenogram.

The treatment consisted merely of rest in bed for three weeks without any type of fixation, and, after an additional week in the hospital as an ambulatory case, the patient was discharged on the twenty-eighth day after the accident, symptom-free and with no demonstrable physical signs relating to his injuries. He was seen about seven weeks later on a return visit to the Clinic and at this time had no symptoms or signs referable to the fractures.

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# FRACTURE OF THE FIRST RIB UNASSOCIATED WITH FRACTURES OF OTHER RIBS

## A Case Report

BY TOM OUTLAND, M.D., F.A.C.S., AND C. R. HANLON, M.D.,
SAYRE, PENNSYLVANIA

*From The Guthrie Clinic, The Robert Packer Hospital, Sayre, Pennsylvania*

Fractures of the first rib are stated to be very rare by most texts and, as a matter of fact, are seen very infrequently in routine traumatic work. Recently Breslin has reported five cases of fracture of the first rib with a review of twenty-seven other cases which he found in the literature, along with a discussion of the anatomy, mechanism, pathology, symptoms, complications, and treatment. He emphasizes the fact that, although fractures of the first rib are rare, their presence should be considered in patients who complain of a "sticking pain" in and around the shoulder region, particularly in those patients who, after severe trauma, do not show signs of fracture of the neck, clavicle, or humerus.

Regarding the mechanism, Lane, the English anatomist, has suggested that fracture of the first rib may occur only in one of three ways: (1) as the result of indirect violence, the force being transmitted through the clavicle; (2) directly by means of force applied behind; or, (3) indirectly by force transmitted through the manubrium.

Fracture of the first rib is important because serious complications are liable to develop. The most significant of these are: (1) abscess formation above and below the clavicle; (2) rupture of the apex of the lung; (3) emphysema; (4) pleurisy; (5) hemorrhage; and (6) nerve symptoms which may come on immediately or a few months after the accident when the callus is of sufficient size to encroach upon the nerve pathways. Rebhorn reported one interesting complication of fracture of the first rib,—namely, the development of Horner's syndrome in a male, twenty-one years old, who had suffered a squeezing violence to the upper part of the chest.

Because of the rarity of this fracture and the complications which may develop, the authors wish to record the following case.

W. R., male, twenty-one years of age, was recently admitted to The Guthrie Clinic in shock, having been pinned in the rumble seat of an automobile when the car had crashed into a post. He complained of backache, inability to move the left arm, and difficulty in breathing. Respirations on admission were 48 per minute. Active or passive attempts to flex the neck caused great pain. Expansion was limited bilaterally on admission and many coarse râles were heard over both lung fields on auscultation. The patient did not complain of pain on deep inspirations.

The roentgenogram taken after admission (Fig. 1) showed fractures of the vertebral ends of both first ribs with no displacement of the fragments. A fracture of the lamina

axis of the bearings should be vertical to the face of the lid, so that the pointer does not scrape the dial anywhere in its travels. The rear end of the axle must not be so long as to bear on the inside of the box when the lid is pressed into place.

The weight of the completed instrument is about three ounces.

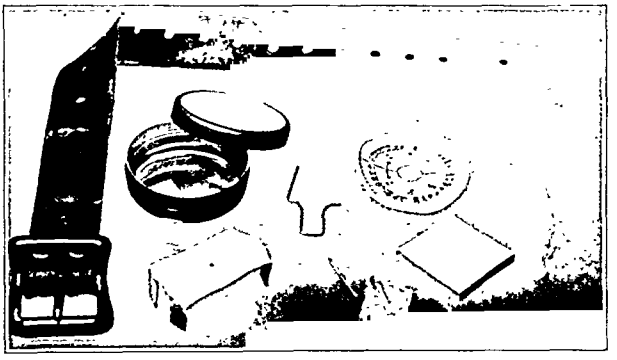


FIG. 3

The parts of the arthrometer. An extra pointer has been included to show the shape of the wire without the lead casting.

In use (Fig. 4) the instrument is strapped to the part distal to the joint to be measured, and the limb is arranged so that rotation about the joint occurs in a vertical plane. The parts are fixed at any given angle (straight, at a right angle, etc.) and the dial is set at a corresponding reading by twisting the lid on the box. The operator then fixes the part proximal to the joint with one hand while he steadies the instrument and guides the patient with the other. Care must be taken to see that the muscle and soft-tissue movements do not cause the instrument to rotate slightly on the part. The measuring process should be repeated two or three times until the operator is satisfied that he has an accurate reading.



FIG. 4

Showing the use of the arthrometer to indicate the range of motion in the elbow joint.

The instrument has been especially useful in determining the return of elbow-joint function following fracture of the lower end of the humerus, but with more or less ingenuity it can be used for most of the other motions of the body.

# A COMPACT PENDULUM ARTHROMETER

BY JOHN G. HAND, M.D., PHILADELPHIA, PENNSYLVANIA

The commercial instrument for measuring the range of joint motions designed in 1918 by Falconer is unsatisfactory for use on children and on small adult joints, because its weight makes it unwieldy and difficult to use accurately. However, such an instrument is of great value in measuring the motions of the extremities, and a compact model will be used daily in the clinic because of its ease of application and rapidity of use.

Excellent service has been obtained in two fracture clinics from a small home-made instrument (Fig. 1) which is readily fitted to a young child's forearm, hand, or foot. It is made from an ointment box and is constructed without technical finesse, as follows:

A one-ounce ointment box is fastened to a strap by riveting, or construction of a metal slot soldered to the back, as shown in Figure 2. A dial, graduated in 5-degree units, half reading clockwise and half counter-clockwise, is glued to the label. (This may be made accurately by photographing to scale a large dial which has been carefully drawn, and using a print of this photograph.)

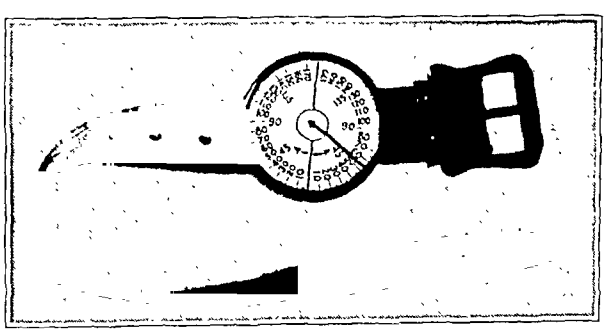


FIG. 1

The arthrometer.

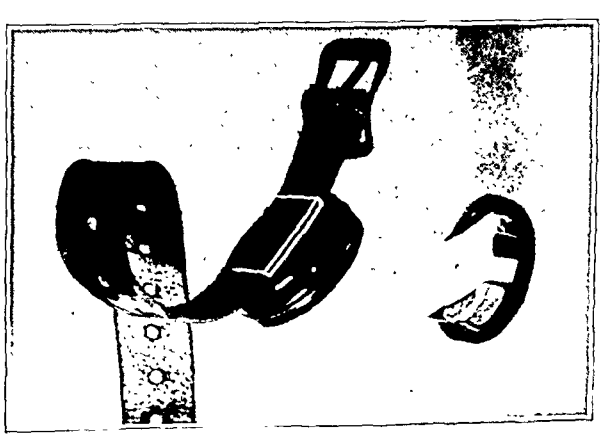


FIG. 2

Rear view of case, showing attachment of strap; and inside of lid, showing mounting of pendulum.

A pendulum is then constructed by casting about thirty grams of lead in a quadrant-shaped mold and incorporating a piece of steel music wire, bent as shown in Figure 3. The caliber of the wire is about five-hundredths of an inch, and the wire serves as an axle for the weight and as an indicator for the dial. The indicator arm should be ground to a point and painted black.

The pendulum-pointer unit is passed into a hole, drilled in the center of the lid of the ointment box, from within, so that the pointer is outside, the weight inside, and the unit held in this position by a bearing made of tin, soldered to the back of the lid. The

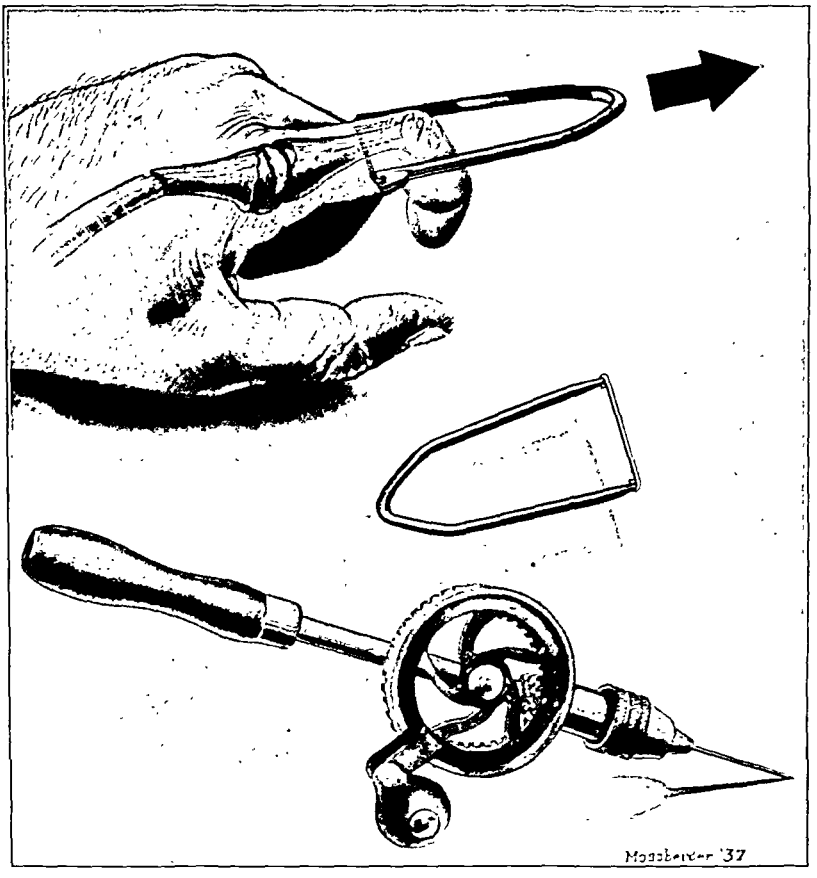


FIG. 1

both in regard to efficiency and the patient's comfort. In addition to oblique fractures and some transverse fractures of the long bones of the hands and feet, fracture-dislocations of the interphalangeal joints have also been reduced and the position has been maintained. In many cases of badly comminuted Colles' fracture, better results can be obtained with traction which can easily be applied by this method through the thumb or the index finger.

# A METHOD FOR SKELETAL TRACTION TO THE DIGITS

BY G. MOSSER TAYLOR, M.D., AND ALONZO J. NEUFELD, M.D.,
LOS ANGELES, CALIFORNIA
*From the Department of Orthopaedic Surgery, College of Medical Evangelists*

The use of skeletal traction has rapidly become an accepted procedure in the treatment of fractures. Its application to the fingers has progressed somewhat more slowly. Too often the size of the transfixing pin is out of proportion to that of the phalanx. There is also the problem of how best to fix the traction to the pin. For these reasons the less complicated methods for applying traction to the fingers—such as adhesive plaster, celluloid dressings, fingernail traction, and pins through the pulp of the finger tip—have been in vogue. The most efficient, as well as the most comfortable type of traction, especially where considerable pull is necessary, is that applied directly to bone. More general use of skeletal traction to the fingers and toes would no doubt result were there an easy and simple method of application.

The apparatus which the authors have devised for this purpose consists of a wire of minimal size, an ordinary small Yankee drill such as may be purchased in any notion store, and a simple C clamp. The wire is stainless steel of the smallest size—8-gage piano wire such as is usually sold for the Kirschner outfit. This wire is cut to appropriate lengths and on one end of each is made a drill point. Tonsil-snare wire may be used, but of course this is not stainless. The drill is a cheap variety of the Yankee drill. A small tunnel may be made deep to the chuck to take up further length of the wire. When using the drill it is better to employ an alternating motion than to keep jerkily trying to turn it in a continuous circular manner. The C clamp is made of 8-gage spring-steel wire. Each prong is drilled one-sixteenth of an inch from the end in the axis common to both prongs a little larger than the wire it is to receive. The wire may be inserted through any phalanx, but in general a point should be used as close as possible to the lesion.

After the skin has been sealed with tincture of benzoin and gauze, the ends of the wire are cut to the required length and turned back 180 degrees with a Kelly clamp or a prong of the C clamp itself. The wire is then ready for the application of the C clamp which supplies the tension to keep the wire taut. This is facilitated by the use of a pair of ordinary slip-lock pliers or medium-sized hemostats to hold the tension of the C clamp while hooking it onto the wire. The manner of hooking the wire is shown in Figure 1. In turn, traction is made on the clamp through rubber bands which are secured to the usual banjo splint or to a hooked wire embedded in a plaster cast.

This method of applying traction to the digits has been used by the authors during the past two years, and has given entire satisfaction



FIG. 1-A

Lateral roentgenogram showing fracture extending diagonally from the distal margin of the tibial tuberosity into the subchondral cortex.

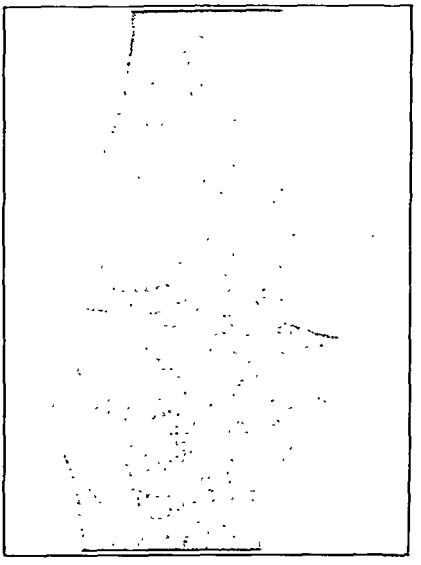


FIG. 1-B

Anteroposterior roentgenogram showing elevation of the floor of the lateral portion of the knee joint.

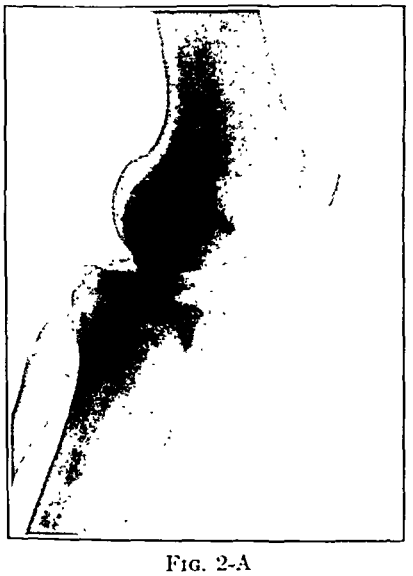


FIG. 2-A

Lateral roentgenogram showing firm union, with preservation of the epiphyseal line in the posterior part.



FIG. 2-B

Anteroposterior roentgenogram showing normal alignment.

remained seemed a bit dubious. Upon exposure, a large amount of dense scar tissue, completely covering the fragment, was found. Whether this was evolved from the periosteum, from the joint capsule, or from the surrounding ligaments was not determined. The layer of tissue was the thickness of the little finger and seemed to present

# THE USE OF "PERIOSTEAL SUTURES" IN OPEN FIXATION OF FRACTURES OF THE TIBIAL CONDYLE

## Report of One Case

BY LESTER E. GARRISON, M.D., F.A.C.S., AND MONROE GARRISON, M.D.,
CHICAGO, ILLINOIS

*From the Surgical Division of Mercy Hospital, Chicago*

It is the purpose of this report to call attention to what might be termed a variation of technique in the operative fixation of condylar fractures of the tibia. The method was discovered somewhat by accident. It will not be applicable to every case, especially to those in which there is a gap between the fragments. Where it can be used, it represents a rapid and easy means of procedure. It greatly shortens operating time and may prevent the rarefaction of bone that too often follows pin or nail insertion. It should not be overlooked in cases that present a patent epiphyseal line.

This technique has been termed the use of "periosteal sutures" largely because of lack of a better name.

### CASE REPORT

F. K., male, aged fifteen, was admitted to the Surgical Service of Mercy Hospital on March 26, 1935. On the previous day he had fallen while running, striking the right knee and thigh. He did not recall whether or not the knee had been wrenched. It had been impossible for him to bear weight on the leg immediately after the accident. Swelling had followed at once and, according to the patient's description, it extended from the knee to the ankle.

Examination at the time of admission showed the right knee, lower thigh, and upper leg to be markedly enlarged. A large hematoma was present over the tibial tuberosity and smaller hematomata were scattered about the knee joint. Bony landmarks were obliterated. Because of the great swelling and tenderness, accurate palpation was impossible. After incorporation of the limb in a posterior metal splint, anteroposterior and lateral roentgenograms were taken.

The lateral roentgenogram (Fig. 1-A) showed a fracture extending diagonally from the distal margin of the tibial tuberosity into the subchondral cortex. The fragment was wedge-shaped and included most of the tuberosity. It had been tilted upward by the action of the quadriceps, displacing the patella above the intercondylar groove. The fracture line had followed the growth cartilage and had then broken into epiphyseal bone. The anteroposterior roentgenogram (Fig 1-B) showed elevation of the floor of the lateral portion of the knee joint. The fibula was uninvolved.

The position of the fragments and the displacing force exerted by the upward pull of the quadriceps indicated an open reduction. It was thought advisable to wait for a few days to allow the swelling to decrease. Accordingly, the extremity was immobilized in a short plaster spica to minimize muscle pull. It was hoped that complete avulsion of the fragment might be prevented. During this time, complications developed. The parents refused to believe that a "broken bone" required surgery. As a result, operation was not performed until April 9, or two weeks after the injury.

Under anaesthesia, the knee was again palpated and the fragment was found to lie entirely laterally. Crepitation was pronounced. That attachment to the shaft yet

TABLE II

CASES OF OSTEITIS OF SEPTIC OR UNCERTAIN ORIGIN

| Case No. | Hospital No. | Sex | Age (*Years*) | Localization | Abscess | Fistula | Sequestrum | Treatment | Result at Discharge | Pathological Diagnosis | Follow-up Examination | Fig. No. | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 392/30 | Male | 24 | Right tuber ischii and superior ramus of the ischium | None | Yes | Yes | Sequestrectomy and gouging | Healed | | Healed. No symptoms from the hip joint | 8 | |
| 10 | 610/32 | Male | 24 | Superior ramus of the right ischium | None | Yes | None | Conservative | Healed | | | | |
| 11 | 143/33 | Male | 22 | Superior ramus of the ischium | None | None | None | Conservative | Healed | | Healed. No symptoms from the hip joint | | Septic chronic inflammation of the left trochanter. The Wassermann, Sachs-Georgi, and Kahn reactions were negative. The Mantoux reaction was negative to three milligrams. |
| 12 | 385/33 | Male | 38 | Left tuber ischii and superior ramus of the ischium | None | Yes | None | Sequestrectomy and gouging | Healed | | Healed | | The Wassermann, Sachs-Georgi, and Kahn reactions were negative. Pirquet's reaction was positive. |
| 13 | 226/34 | Male | 17 | Superior ramus of the right ischium | None | Yes | None | Partial subperiosteal resection of the superior ramus | Healed | Subacute inflammation without specific changes | Healed | | Pirquet's reaction was negative; the Mantoux reaction was negative to three milligrams. |

an excellent means of fixation. The fragment was replaced with a mallet. Two mattress sutures of No. 2 chromic catgut were placed through the scar tissue, each in an opposite direction to equalize the pull, and snugly tied. Upon inspection it was seen that normal alignment of the bone was again established. The wound was closed in the routine manner. A long spica cast was applied.

Recovery was uneventful. The patient was discharged on crutches on the ninth postoperative day. Four weeks after operation, the spica was removed and a long leg cast was applied. This second cast was removed in three weeks and the patient was told to use the leg as desired. He was seen again in two weeks, nine weeks from the time of operation. Active flexion to 90 degrees was possible. Passive flexion was not attempted. There was complete extension, but lateral rotation of the foot and leg was limited.

The patient was told to return in one year. He was next seen on July 3, 1936, at which time a second series of roentgenograms was taken. The lateral roentgenogram (Fig. 2-A) showed complete and firm union, with preservation of the epiphyseal line in the posterior part. The anteroposterior view (Fig. 2-B) revealed normal alignment. The former line of fracture was indistinct. All motions were complete. The patient walked well, with complete absence of limping and pain.

## DISCUSSION

The report of these rather unusual findings is presented in the hope that it may be of value. We have been unable to find a similar technique in the literature. The formation of anomalous tissue and the ease of operation make one think that it may be advisable to wait ten days or two weeks in all open reductions of fractures of this type.

The derivation of the scar tissue is in doubt. Most probably, it came from the fibrous layer of the periosteum. We confess negligence in not obtaining a piece for microscopic examination, but whether or not this would have revealed any clue as to the origin remains debatable.

We hesitated to use pegs or nails in this operation because of the evident patency of the epiphyseal line. Adequate fixation could probably not have been obtained without piercing the growth cartilage. Although the boy was large and evidently had attained full stature, the upper tibial epiphysis does not completely ossify until the age of nineteen at least. Trauma to a center of possible future growth is surely not compatible with the best surgical technique.

During a recent bit of research (under the direction of Dr. Edward L. Compere of the University of Chicago), it was discovered that drilling the upper femoral epiphyses of experimental animals caused distortion of growth, sometimes so slight as to be visible only on the dissected specimen. Insertion of bone pegs or chips resulted in a more serious disturbance of growth with greater deformity, while curettage of the epiphyseal margins gave what might be called the maximal deformity.

Because of these findings, it was concluded that all surgical manipulation in the region of active epiphyseal lines is to be avoided.

# A SIMPLE TECHNIQUE FOR INSERTING THE SMITH-PETERSEN NAIL

BY DON KING, M.D., F.A.C.S., SAN FRANCISCO, CALIFORNIA

*From the Stanford University Surgical Service, San Francisco Hospital Unit of San Francisco Department of Public Health*

The following simplified technique has been found to be practical and accurate and has been used in thirty femoral-neck fractures. The results have proved that roentgenograms following manipulation, complicated protractor apparatus, and preliminary insertion of guide wires are unnecessary.

The nail length required is calculated as follows: A lead tape, three and one-half inches long, is fastened to the skin just below the greater trochanter of the normal hip and a posterior roentgenogram (Fig. 1) is taken. Since the lead tape and the femoral neck are about the same distance from the film, the amount of distortion is the same, and hence it is easy to figure the length of nail needed.

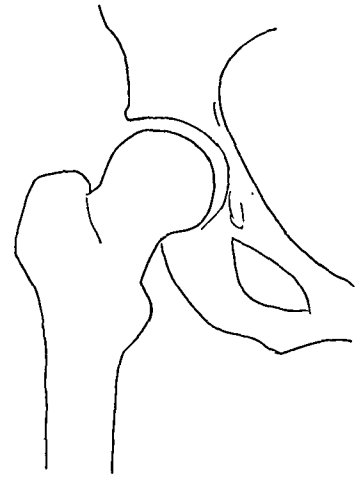


FIG. 1

Tracing of roentgenogram with lead tape, three and one-half inches long, on skin.

The patient is placed on an ordinary operating-room table, with the pelvis resting on a cassette box (Fig. 2), and the fracture is reduced (Leadbetter technique). *No check-up roentgenograms are necessary.* With the extremity held in abduction and internal rotation, a four-inch incision is made, and the origin of the vastus lateralis is exposed and divided for a distance of one inch. A long, stiff wire, bent to the shape of a normal femur, is laid over the lateral aspect of the thigh. The nail is driven in parallel to the short arm of the wire and the floor (Fig. 2). An anteroposterior roentgenogram

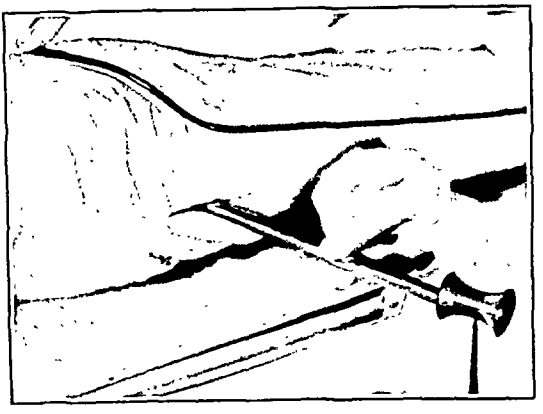


FIG. 2

Cadaver resting on cassette box; angle wire in place indicating position of the neck and shaft; nail being driven in parallel to short arm of wire and floor.



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is then taken. Without moving the tube, the thigh is flexed 90 degrees. As it comes up into flexion, it is allowed to fall into moderate abduction and external rotation. Another roentgenogram is taken, which is a lateral projection. If the direction of the nail needs to be changed, the nail is extracted and reinserted.

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## AN INEXPENSIVE, DURABLE WALKING CAST

BY JOHN S. STEPHENS, M.D., LOS ANGELES, CALIFORNIA

By placing a short section of scrap tire on the bottom of a Böhler-type walking cast for an adult or child, one can obtain a soft, durable, non-skid surface for weight-bearing that is not characteristic of the commonly used strap-iron crutch heel.

Figure 1 shows a cross-section of an automobile tire. The outer tread, the rubber side wall, and the bead have been cut away. The uncut half is shown for comparison. Figure 2 shows the flexible side wall incorporated in the completed cast with layers of plaster.

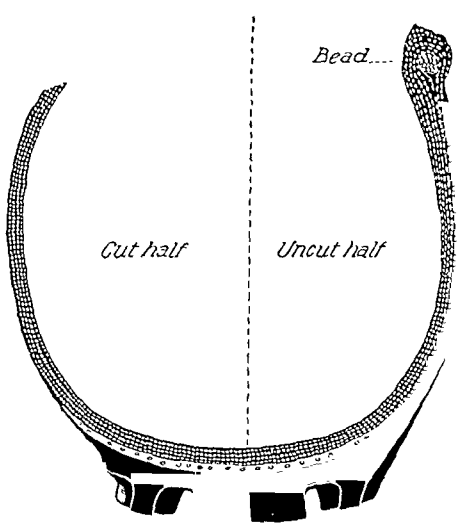



FIG. 1

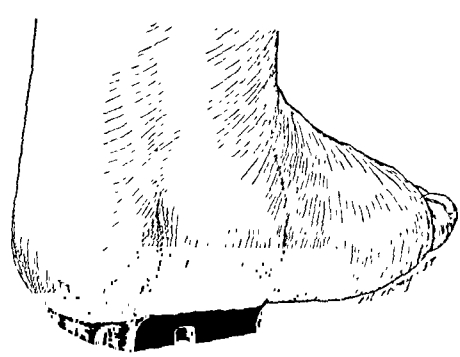


FIG. 2

One should use the smaller type of tire with a thick, unused tread. The wire beads should be removed before the tire is cut into segments with a sharp *oiled* or *wet* knife.

A defective or scrap tire with the beads removed can be purchased for a few cents and can be cut into approximately forty sections, making the cost negligible.

# A MODIFICATION OF THE TRACTION TREATMENT OF SACRO-ILIAC STRAIN

BY ALLAN H. WARNER, M.D., WOODSIDE, LONG ISLAND, NEW YORK

In the treatment of sacro-iliac strain and sciatic syndrome, it is sometimes desirable to maintain traction of one or both lower extremities. This is usually done by Buck's extension, attaching a pail of lead shot to the foot through a projecting pulley arrangement.

Since traction need not always be continuous, the patient is ordinarily permitted to get up for bowel movement, and may be allowed other periods of relaxation. The patient cannot conveniently get in and out of the lead-shot and pulley arrangement without help, and it is desirable to have an apparatus which the patient can handle without any assistance.

The following contrivance has been found simple, convenient, and practicable for home treatment.

The inner tube of a tire is placed around the footboard of the bedstead at the level of the upper surface of the mattress. Two loops, about eight inches in diameter and made of canvas tape or a trouser belt, encircle the inner tube perpendicular to its length, between the rungs of the bedstead. The feet of the patient are placed in the loops, so that the tape hooks above the ankles, the calcaneal tubercles, and the toes. The two loops are about eighteen inches apart.

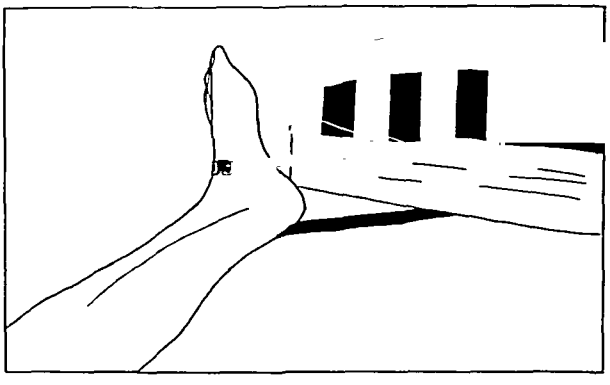


FIG. 1

Showing the strap in position. The strap is prevented from slipping by the forward projection of the tarsal bones and the backward projection of the os calcis.

The foot of the bed is elevated into reverse Fowler's position, and the patient pulls himself toward the dependent head of the bed sufficiently to apply tension on the rubber inner tube. In this way, the patient's body weight opposes the pull of the inner tube.

This position can be maintained for hours at a time without discomfort to the patient. It will usually be found necessary for the patient to pull himself to the head of the bed every once in a while, as the inner tube pulls him the other way.

# A SCREW FOR OBLIQUE FRACTURES

BY R. M. YERGASON, M.D., F.A.C.S., HARTFORD, CONNECTICUT

Who has not had difficulty in maintaining reduction of oblique fractures of the tibia? No matter how well these fractures may be reduced and splinted, the calf muscles are so strong that either the fragments slip into overriding or the long superficial point of one fragment is caused to project under the skin by angulation due to spasm in the muscles.

To meet this annoying situation, the author has used the Carrell-Girard screw, which was found to be quite effective; nevertheless, the wood-screw point did not always hold well in the bone, and the selection of the proper drill to use was difficult as the screws vary in size. Furthermore, the thickness of the bone cortex is only sufficient to contact two or three turns of the wood-screw thread, and, in consequence, the grip of this screw is unsatisfactory. It, therefore, occurred to the author to combine the idea of Carrell and Girard with that of Sherman. The Sherman screw has a tap point and machine thread, and the tap point cuts its own thread in the bone. A machine thread, having a much smaller pitch than that of the wood screw, brings a number of turns into the cortex, so that the grip is much stronger.

The screw illustrated in Figure 1 can be procured, cadmium-plated,* at any hardware store, and the cost is negligible. The tap point is easily added by a few strokes of a fine file, and two nuts may be placed upon it in the way in which Carrell and Girard use them.

A curved incision exposes the fracture. The ends of the bones are cleaned and placed in perfect apposition, and held there by any form of bone-grasping forceps (those used by the author are a simple pair of tongs made with flat, curved jaws to grasp the bone). The tongs are held by an assistant. The hole in the superficial cortex is made with a drill just large enough to allow the screw to slip through. The deep cortex of the other fragment is drilled through the same hole with a drill slightly smaller (the size of the drill is determined by the diameter of the screw less its thread). The screw is then inserted and made to engage in the deep cortex by turning it in with a small screw driver; six to eight half turns are sufficient to get a very strong hold in the deep cortex. By means of a tubular wrench, the two nuts are then turned down upon the superficial cortex, one locking the other. The bone-holding forceps are removed, and the wound is closed, allowing the screw to project. The nuts, of course, are buried below the skin, but in the case of the tibia they are quite superficial. The screw is buried in the sterile dressings, and only a light molded plaster splint is necessary.

The patient is allowed up on crutches as soon as swelling has sub-

* Cadmium plate seems to be well tolerated by the tissues. Two screws which have been in a femur for three months look unused.

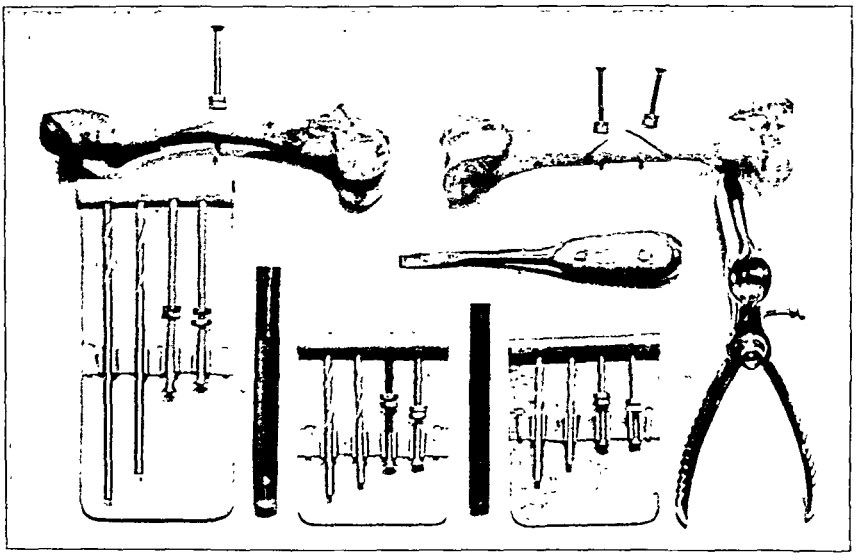


FIG. 1

Showing the three common sizes of screws with their appropriate drills in clips for convenience in boiling, tubular wrenches, small screw driver, and rectal speculum. The two lamb bones illustrate the appearance of the screws in place.

sided, which may be in two or three days after operation. The patient may be discharged from the hospital in a short time and may come on crutches to the office for the removal of stitches. After from two to three weeks, when sufficient callus has appeared and healing of the soft parts about the bone has taken place, the screw may be removed with ease. It will be found necessary to turn the screw out of the deep cortex, which will probably require the use of an artery clamp. Three or four turns loosen the screw from the deep cortex and it can then be withdrawn with the fingers. In such a short time as three weeks the wound will not have healed around the screw so tightly as to make difficult the withdrawal of the screw bearing the nuts.

The author has used this screw in situations where, the nuts being deeply covered by soft parts, the skin has healed around the screw closely, requiring a little nitrous-oxide anaesthesia to open the wound slightly and thus facilitate removal of the screw.

In fractures of the femur, when the line of fracture is toward the wound, it may be best to insert the screw from a different direction. For this, a two-inch incision through skin and fascia allows a bivalve rectal speculum (Sims-Botenhamer) to be inserted. The speculum can be opened enough to permit it to ride astride the bone, and through it the drilling and insertion of the screw are easily accomplished without undue trauma to the perforated tissues. Extra long drills (five inches) are necessary in working through the speculum.

Different lengths of the screw lend themselves to oblique fractures of the femur. In such a fracture near the knee, the fragments are very apt

to kick out of position by the pull of the gastrocnemius and hamstring muscles, and reduction is very difficult to maintain by other methods. There is only one point to be carefully observed and that is to make sure that the drill which is to be used in the deep cortex is just the right size, which is determined by the diameter of the screw less the thread. The drill for the superficial cortex may be a bit large, as the nuts will hold the screw satisfactorily. At the same time, it is best to have this drill just the right size to allow the screw to pass through easily.

Drills supplied by surgical instrument houses, as well as those from hardware stores, all seem to have rather dull points beveled at an angle of 60 degrees. Such drills slip off the bone or migrate sideways when the hole is started. It is a great convenience to have the points reshaped at 30 degrees, which obviates this mishap.

This rather simple open reduction assures perfect maintenance of position with a short period of hospitalization, which markedly reduces the period of disability.

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# SPINAL HYPEREXTENSION LITTER

BY RALPH D. PADULA, M.D., NORWALK, CONNECTICUT

The management of fractures of thoracic and lumbar vertebrae in the last decade has changed considerably with the advent of newer and better methods of transportation. Traffic casualties and disasters have accelerated the number of crushing injuries and fractured vertebrae. Laymen, ambulance drivers, or recent medical-school graduates have little or no practical experience in the application of splints, diagnosis, and transportation of injured.

It is the author's contention that a majority of fractures of the vertebrae are not complicated by cord injuries as a result of the accident, but complications arise from the improper care in handling these patients after the accident. It is a well-known fact that by far the largest number of fractures of the vertebrae are produced by forcible hyperflexion of the bony vertebral skeleton. This induces compression of the anterior portion of the bodies of the vertebrae, with or without torsion and lateral displacement.

In conveying the patient to a hospital, it is very important to keep the back in a hyperextended position from the time of the accident to the final disposition of the case. A patient is moved at least five times from the point at which he is picked up to the taking of the roentgenogram. It is difficult to ascertain when a fracture, not complicated by paralysis immediately after the accident, receives the trauma necessary to cause injury to the spinal cord. Frequently diagnosis of a broken back is not made until paresis of the bladder and paralysis of the lower extremities occur. The fracture then can only be definitely determined as a result of a roentgenographic examination. The axiom which we believe should be followed in the treatment of fractured vertebrae is: "Splint them where they lie."

The mobile hyperextension method of transportation and treatment of the injured causes the patient to be moved only once. Treatment with this hyperextension method consists of forcible reduction of the fracture. Some patients, however, are placed in a hyperextended position and manipulated under general anaesthesia. The fracture is then immobilized in a plaster jacket or plaster spica.

For the past seven years the writer's interest in fractures of the thoracic and lumbar vertebrae has been quickened, with emphasis on the appropriate transportation, diagnosis, and treatment. Dr. George Hawley, of Bridgeport, donated his wide experience in fractures and piloted the author through this work. The old adage, "Splint them where they lie", was unremittingly emphasized by Dr. William Darrach, Dr. Clay Ray Murray, and Dr. Barbara Stimson during the writer's residency at the Presbyterian Hospital. Their views were responsible for his interest in the development of this mobile hyperextension frame.

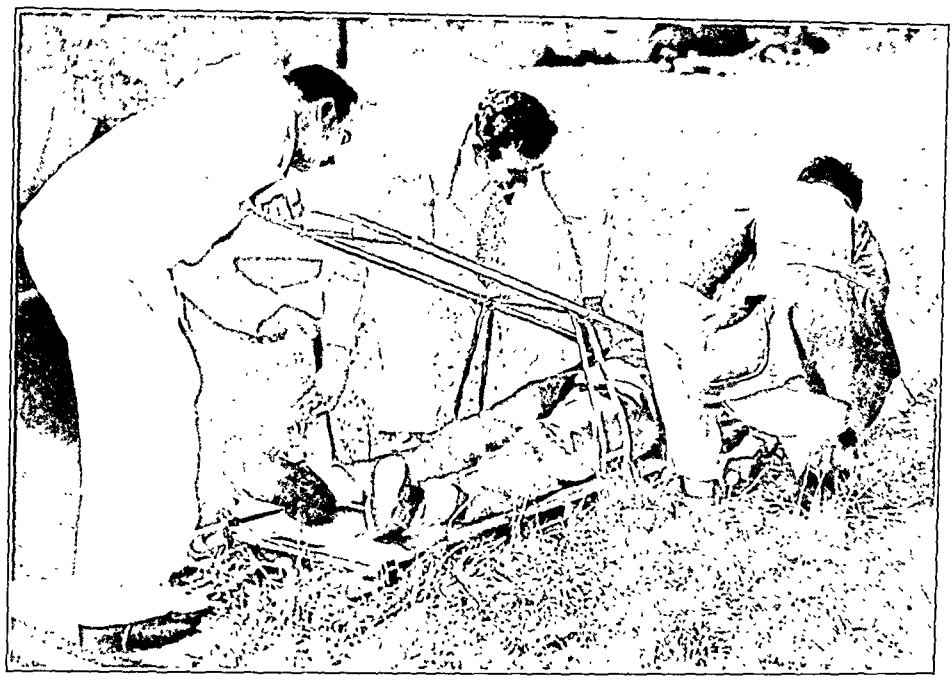


FIG. 1

Attachment of suspensory band.

This hyperextension frame was designed and fashioned to be permanent equipment in all standard ambulances. This table can be safely strapped to the ceiling without detriment to room and efficiency. It consists of a stretcher, a hoisting frame, a lever frame, and a suspensory band.

The stretcher portion of the frame is seventy-two inches by twenty inches and is made of light, chromium-plated, half-inch steel tubings. It

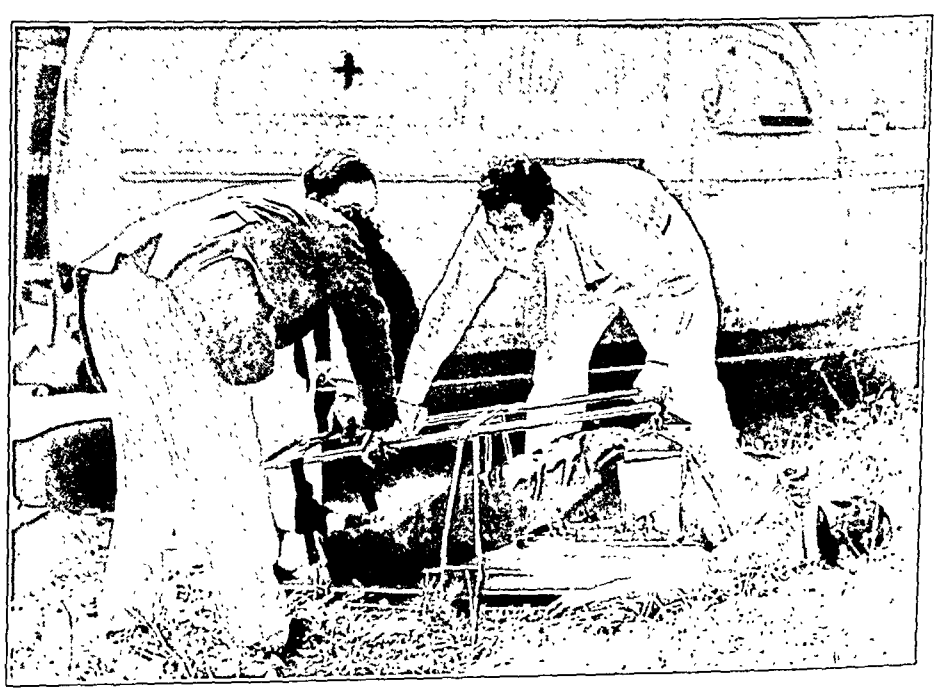


FIG. 2

Hyperextension of spinal column.

is reenforced on the under side by light steel cross-bars. The ends of the horizontal bars are turned in the shape of a U, which makes a very effective hand grip. The upper surface of the stretcher is made of teakwood, one-half an inch thick, and covered with a one-piece removable pneumatic mattress.

The hoisting frame is twenty inches high and twenty inches wide, and is made of half-inch chromium-plated steel tubings in the shape of an inverted U, with the twin legs of the U fitting into a specially designed fixture. Once the hoisting frame is placed in position, it is capable of withstanding at least 500 pounds of pressure without being displaced in any direction. The rounded end of the U is a continuation of the twin legs of the U, so that it makes a perfect receptacle for the lever frame.

The lever frame is forty-eight inches long and twenty inches wide, and is also made of half-inch chromium-plated steel tubings in the shape of a rectangle with the end bar slightly curved. There are two reenforcing cross-bars made of the same tubing as the rest of the frame. The anterior bar is made to fit into the rounded end of the hoisting frame, premitting thirty inches of the lever frame to elevate the suspensory band.

The suspensory band is made of 18-gage half-hard aluminum sheets, this material being chosen because it bends easily to conform to the contour of the body and for the taking of anteroposterior and lateral roentgenograms. This band comes in different sizes—eight inches by twenty inches, six by eighteen, and four by fourteen—to be used according to the size of the patient.

The hyperextension stretcher is taken out of the ambulance and carried to where the injured person is lying. The suspensory band is slipped under the small of the back, producing a moderate amount of hyperexten-

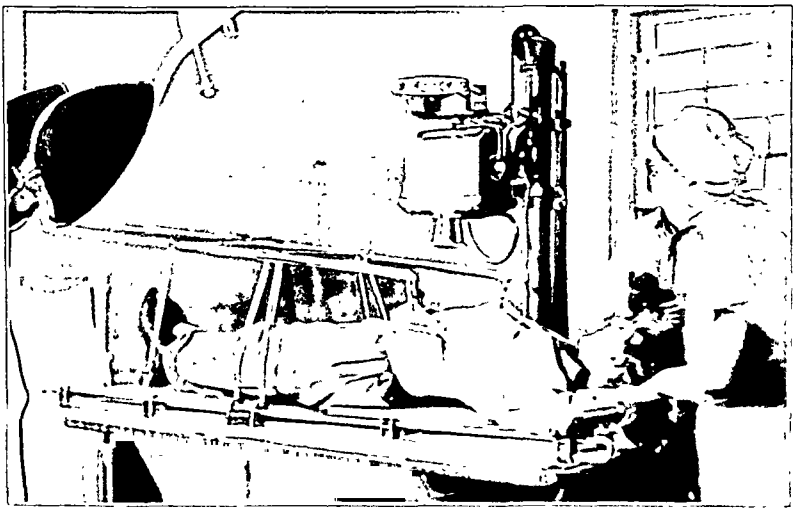


FIG. 3

Showing patient in position for taking an anteroposterior roentgenogram.

sion. With the hyperextension maintained, the patient is gently placed on the stretcher portion of the frame. The hoisting frame is fixed in position on the stretcher. The lever frame is placed in position in the hoisting frame. The suspensory band is attached to the lever frame and, by pressure on the posterior portion of the lever frame, the required amount of hyperextension is produced and maintained by locking the strap between the lever frame and the stretcher. The patient on the hyperextension frame is very easily transported to the ambulance in much the same way that he would be carried on any other stretcher.

## SUMMARY

1. The same consideration should be given to fractures of the spinal column as to fractures elsewhere in the body. Restoration of normal bone-and-joint contour of fractured vertebrae is just as essential to restoration of normal function as it is in fractures elsewhere in the body.

2. Fractures of the vertebrae without cord changes can easily be converted into fractures with cord symptoms by improper handling and transportation of a patient to the nearest point where a diagnosis and competent treatment can be obtained.

3. Splinting of fractured vertebrae where the patient lies is just as important as splinting fractures of long bones to prevent serious complications from arising.

4. Early diagnosis, early reduction, and early immobilization of fractured vertebrae are the factors which comprise the ideal care of this type of injury.

5. Delayed cord symptoms, following fractures of vertebrae as a result of hemorrhage, will, in a majority of cases, be eliminated by an early reduction of the fractures. The mechanical reduction of the deformity will usually stop the hemorrhage and prevent delayed spinal-cord paralysis.

6. The mobile hyperextension stretcher frame is so designed and constructed that the patient is moved only once, making it unnecessary to move him again to make the diagnosis, to reduce the fracture, and to immobilize the fracture.



## PATRIK HAGLUND

MAY 27, 1870–DECEMBER 8, 1937

Patrik Haglund died suddenly on December 8, 1937, in an attack of angina pectoris, having been occupied earlier in the day with his daily routine of work.

Prof. Haglund was born in Norrköping, Sweden, on May 27, 1870, and began his career by taking a university degree in astronomy and physics. He then transferred to the medical faculty, where he received the degrees of Licentiate in Medicine in 1899 and Doctor of Medicine in 1903. He became a lecturer in Orthopaedic Surgery at the Caroline Institute in Stockholm and was elected Professor of Orthopaedic Surgery in 1913, in which capacity he remained until 1935 when he retired as an Honorary Professor.

Prof. Haglund received his surgical training with Prof. Karl Gustav Lennander, the famous Uppsala surgeon. In him Prof. Lennander found a pupil who, with his mechanical inclination and biological outlook, seemed well adapted to devote his abilities to orthopaedic surgery. This branch of surgery, which at the end of the last century had begun to assume an independent position both scientifically and from the point of view of organization, especially in Germany, had as yet no representative in Sweden. His

through in the longitudinal direction of the tuber ischii or of the superior ramus and then is carefully elevated by a raspatory. After the removal of all morbid bone, the periosteum is sutured.

The author wishes to express his gratitude to his Chief, Dr. Robert Hanson, for his kindness in placing material at his disposal.

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# News Notes

The eighth **Sir Robert Jones Lecture** was given by Dr. Frederick C. Kidner at the Hospital for Joint Diseases on February 24, 1938. The subject of Dr. Kidner's address was "Congenital Dislocation of the Hip".

Dr. Theodore H. Vinke announces the removal of his office to Suite 709–710 Carew Tower, Cincinnati, Ohio.

Dr. Paul C. Colonna of New York City has been appointed head of the Department of Orthopaedic Surgery at the Oklahoma University School of Medicine. He has moved to Oklahoma City and his office is now at the Crippled Children's Hospital.

The next examination of the **American Board of Orthopaedic Surgery** will be held in Chicago on June 10 and 11, 1938. Detailed information in regard to this examination may be obtained from the Secretary, Dr. Fremont A. Chandler, 6 North Michigan Avenue, Chicago, Illinois.

The **Chicago Tumor Institute,** opened on March 21, 1938, offers consultation service to physicians in the diagnosis and treatment of cancer and radiation facilities for cancer patients. The Institute also proposes to conduct research and to offer training to physicians who may wish to qualify as specialists in the study and treatment of this disease.

The next Congress of the **Czechoslovakian Orthopaedic Society** will be held in Prague early in July 1938, at the same time as the Pan-Slavonic Medical Congress and the Pan-Sokol Railly. At this Congress, Prof. Zahradníček will discuss "Pseudarthrosis" and Dr. Frejka, "Necrosis of Bone".

The **Occupational Therapy Curative Workshop,** with offices at 101 North Jefferson Street, Richmond, Virginia, has recently been established in connection with the Wheeldon Orthopaedic Foundation. This will supplement and aid the work of the Foundation which was incorporated two years ago for the purpose of providing without charge the facilities for treating orthopaedic cases. Dr. Thomas Wheeldon of Richmond has been elected Medical Director.

The **Réunion d'Orthopédie et de Chirurgie de l'Appareil Moteur de Bordeaux** took place in Bordeaux on January 27, 1938. The following papers were presented by members and by guests:

Arthrodesis of the Shoulder by the Method of Leveuf and Bertrand—Dr. E. Papin.
Open Dislocation of the Elbow—Dr. E. Papin.
Resection of the Knee—Dr. R. Charry, of Toulouse.
The Use of the Bone Graft in Pseudarthrosis of the Humerus—Dr. L. Dieulafé and Dr. R. Dieulafé.
An Apparatus to Maintain Extension in Fractures of the Leg—Dr. P. Forton.
Myeloplaxoma of the Horizontal Ramus of the Pubis, Treated by Curettage and Osteoperiosteal Graft—Dr. H. L. Rocher.
Some Syndromes of Multiple Fractures—Dr. L. Pouyanne.
The Danger of Faulty Technique in Osteosynthesis by Plate—Dr. C. Lasserre.
Coxalgia Superimposed on Congenital Dislocation of the Hip Previously Reduced. Fixation of the Hip—Dr. M. Dehtch, of Yugoslavia.

orthopaedic training Prof. Haglund obtained mainly from Prof. Albert Hoffa whom he served as an assistant over a long period.

In good times as in bad, and despite opposition, Prof. Haglund went forward imbued with a sole and great idea,—the care and treatment of the crippled. He was the true mainspring of Swedish Orthopaedic Surgery as it presents itself today. As an organizer, he gave evidence of great foresight and had a tremendous influence on orthopaedic treatment in the whole of Scandinavia.

As a scientific writer, he was remarkably productive. His writings number nearly 300 in all. His most important work was "*Prinzipien der Orthopädie*", published in 1923, an exceedingly original and subjectively colored handbook on the most important chapters in orthopaedic surgery. The whole work may be considered a battle cry against a too one-sided morphological orthopaedic outlook under emphasis of the dominating importance of function.

By those who knew Patrik Haglund he will be remembered as a man of exceedingly kindly disposition, always very helpful to others. He had a very lively intellect and what he liked most of all was to associate with his young assistants, having the mind of youth even in his later years.

On Tuesday evening, May 3, there will be a reception for the members of the American Orthopaedic Association and the Congress of American Physicians and Surgeons, and the President of the Congress will give an address.

On Wednesday afternoon, May 4, there will be a joint session of the Association and the Congress, and on Wednesday evening the Annual Dinner of the American Orthopaedic Association will be held at the Ambassador Hotel.

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The Twentieth Congress of the **Société Française d'Orthopédie et de Traumatologie** will be held in Paris on October 7, 1938, at the *Faculté de Médecine de Paris*, under the presidency of Prof. H. L. Rocher, of Bordeaux. The subjects to be discussed are: "Painful Vertebral Kyphosis Due to Dystrophy" and "Simultaneous Fractures of the Shafts of Both Bones of the Forearm".

The Society will visit the orthopaedic centers of the important cities of Switzerland at the end of September 1938.

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The Twenty-Third Annual Meeting of the **Association of Industrial Physicians and Surgeons** will be held concurrently with the Second Annual **Midwest Conference on Occupational Diseases** on June 6 through 9, 1938, at the Palmer House, Chicago, Illinois. The President of the Association of Industrial Physicians and Surgeons is Dr. R. R. Sayre of the United States Public Health Service. Scientific and technical exhibits will be an important feature, and information in regard to the exhibits may be obtained from Mr. A. G. Park, Convention Manager, 540 North Michigan Avenue, Chicago, Illinois.

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The Eighth **Internationaler Kongress für Unfallmedizin und Berufskrankheiten** will be held in Frankfurt am Main on September 26 to 30, 1938, under the presidency of Prof. Dr. Martineck. The leader of the Section on Industrial Medicine will be Prof. Dr. Magnus of Munich, while Dr. Koelsch, also of Munich, will conduct the Section on Occupational Diseases.

The subjects to be discussed by the Section on Industrial Medicine will be affections of the peripheral nerves and foot injuries.

Further information may be obtained from Dr. Bauer, 13–15 Unter den Linden, Berlin W 8.

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The Fourth International Exhibition of Cripples' Work was held at Edinburgh on October 14, 15, and 16, 1937, under the auspices of the **Central Council for the Care of Cripples.** Sixty-six organizations took part in this exhibit, including one from Canada, one from South Africa, one from Labrador, two from Australia, and four from the United States. The Exhibition was divided into two sections—Adults and Children—and the standard of work displayed showed a marked advance over that of the 1934 Exhibition. Doctors, teachers, and others interested in the care of cripples visited the stands and attended the film displays, lectures, and demonstrations.

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The **American Physicians' Art Association,** a national organization of medical men who have ability in the fine arts, will hold its first national exhibition in the San Francisco Museum of Art, San Francisco, California, in June 1938. This first annual exhibition promises to be of unusual interest with entries to be accepted (after jury selection) in the following classifications: oils, water colors, sculpture, photography, pastels, etchings, crayon and pen and ink drawings (including cartoons), wood carvings, and book bindings. Scientific medical art work will not be accepted. All entries close April 1, 1938. Further information may be obtained from the Secretary of the American Physicians' Art Association, 521 Flood Building, San Francisco, California.

The Fifty-Second Annual Meeting of the **American Orthopaedic Association** will be held in conjunction with the Congress of American Physicians and Surgeons in Atlantic City, New Jersey, on May 2, 3, 4, and 5, 1938, under the presidency of Dr. Frederick C. Kidner. Headquarters will be at the Ambassador Hotel. Among the foreign guests expected will be Mr. T. P. McMurray, of Liverpool, England. The tentative scientific program is as follows:

TUESDAY, MAY 3

*Morning Session*

Scalenus Muscle in Relation to Shoulder and Arm Pain.
Dr. Joseph A. Freiberg, Cincinnati, Ohio.

Osteoporosis.
Dr. Eugene B. Mumford, Indianapolis, Indiana.

An Arthroplastic Procedure for Congenital Dislocation in Children.
Dr. Paul C. Colonna, Oklahoma City, Oklahoma.

Discoid Cartilages or Trigger Knee. Pathology and Treatment.
Dr. Frank R. Ober, Boston, Massachusetts.

Popliteal Cyst (Baker's Cyst). Its Etiology, Pathology, and Treatment.
Dr. Philip D. Wilson, New York, N. Y.

*Afternoon Session*

Symposium on Bone Tumors:

A Review of the Classification of Bone Sarcomata.
Dr. James Ewing, New York, N. Y. (By invitation.)

Analysis of 150 Bone Tumors.
Dr. Robert D. Schrock, Omaha, Nebraska.

Giant-Cell Tumor of Bone.
Dr. Bradley L. Coley, New York, N. Y. (By invitation.)

The Results of Treatment of Osteogenic Sarcoma.
Dr. Henry W. Meyerding, Rochester, Minnesota.

WEDNESDAY, MAY 4

*Morning Session*

True Idiopathic Sciatica. An Effective Method of Treatment.
Dr. Gilbert E. Haggart, Boston, Massachusetts.

A Further Study of the Head and Neck of the Femur in the Growing Child.
Dr. W. Eugene Wolcott, Des Moines, Iowa.

Aseptic Necrosis of the Head of the Femur, Following Traumatic Dislocation.
Dr. Frank N. Potts, Buffalo, New York.

Presidential Address.
Dr. Frederick C. Kidner, Detroit, Michigan.

Osteo-Arthritis of the Hip.
Mr. T. P. McMurray, Liverpool, England. (By invitation.)

THURSDAY, MAY 5

*Morning Session*

Symposium on Non-Paralytic Scoliosis:

Non-Paralytic Scoliosis. Principles of Treatment and Non-Operative Management.
Dr. Arthur Steindler, Iowa City, Iowa.
Dr. W. R. Hamsa, Omaha, Nebraska. (By invitation.)

The Treatment of Scoliosis with the Bent Jacket and Spine Fusion.
Dr. Alan DeForest Smith, New York, N. Y.

The first Executive Session will be held on Tuesday, May 3, at 12:00 noon, and the second Executive Session will take place on Thursday, May 5, at 12:00 noon.

# Current Literature

LA HERNIE POSTÉRIEURE DU MÉNISQUE INTERVERTÉBRAL (HERNIE NUCLÉAIRE POSTÉRIEURE) ET SES COMPLICATIONS NERVEUSES. Pierre Glorieux. Paris, Masson et Cie, 1937. 40 francs.

This work adds, in a particularly clear and convincing way, to the present knowledge on this subject which is now attracting considerable interest and in regard to which there is need of so much further study, both in respect to diagnosis and to treatment.

The author gives a description of the normal anatomy of the nucleus pulposus and the mechanism of the various forms of its protrusion. He has endeavored to show that the lesions can be demonstrated before operation *in vivo* and that the manner of the protrusion of a portion of the nucleus can be established, which disproves the statement so often made that these lesions cannot be demonstrated with any degree of certainty before operation or autopsy.

He lays stress on the importance of the technique of taking roentgenograms and particularly on the management of lipiodol and the position of the patient while the roentgenograms are being taken. The behavior of the fluid as influenced by the position of the body and by change in posture is described, also the changes in the intervertebral disc consequent to the hernia of the nucleus pulposus. The author applies the results of his studies to the clinical consideration both in regard to diagnosis and to treatment.

Illustrative cases are presented in detail, accompanied by excellent roentgenograms taken after injection of lipiodol.

The diagnostic evidence and the value of the physical signs are clearly shown and carefully discussed. The clinical symptoms, however, are not constant or characteristic. It is demonstrated that these herniae are found at autopsy without any history of symptoms. Their origin may be traumatic or non-traumatic. The roentgenographic findings are definite. The author discusses the relation of this evidence to the clinical signs found in the various regions of the spine—cervical, thoracic, and lumbar—and also to the portion of the canal in which the hernia is found, together with the appearance of the disc and the behavior of the lipiodol as influenced by these various regions. There are charts and line drawings to demonstrate the varieties of herniae in each type as influenced by the different positions of the body.

The clinical evidence is considered under the divisions of static symptoms and nerve symptoms and the general reactions and development of the nerve root and central nervous system. The clinical evidence varies greatly both in character and in degree, and it is known that there are no symptoms in many cases in which definite hernia exists. A discussion of bone lesions and fractures with which these herniae are associated, with a consideration of the diagnosis and treatment, completes the volume. Especially interesting are some of the observations as to the indications for operative or non-operative interference.

The author gives the following findings from his investigations and experience:

1. The posterior nuclear hernia does not necessarily present clinical evidence.
2. The symptoms may be purely static.
3. With the static syndrome there are nerve symptoms which, in those cases in which the hernia is in the cauda equina, are purely peripheral or, when the hernia is present in the regions above, are more generally radicular and medullary. The nerve symptoms may be retarded even in the traumatic cases.
4. Neither the static symptoms nor the nerve symptoms are alone distinctly characteristic.
5. The roentgenographic evidence in the lumbar region may be indicative of bilateral hernia and may show dumb-bell or bead formation which is pathognomonic.
6. Unilateral lumbar hernia and all antemedullary herniae do not give a character-

The Spring Meeting of the **British Orthopaedic Association** will be held in London and Oxford on May 27 and 28, 1938.

The Annual Meeting will be held in Birmingham toward the end of October.

At a recent meeting of the Executive Committee, the following orthopaedic surgeons were elected to Associate Membership in the Association:

Mr. F. G. Badger, 4 Plasturton Gardens, Cardiff, Wales.
Mr. J. Barnes, Wingfield Morris Hospital, Headington, Oxford.
Mr. David Brown, Royal Infirmary, Sunderland, Durham.
Mr. A. L. Dawkins, 70 Halton Street, Kensington Park, Adelaide, South Australia.
Mr. L. Gillis, Royal Liverpool Children's Hospital, Liverpool.
Mr. A. J. Helfet, Leasowe House, Leasowe Road, Moreton, Cheshire.
Mr. B. Maken, c/o Standard Bank of South Africa Ltd., 9 Northumberland Avenue, London, W. C. 2.
Mr. P. B. Maroney, 9 Oxford Drive, Waterloo, Liverpool.
Mr. S. Pappworth, 29 Rocky Bank Road, Devonshire Park, Birkenhead, Cheshire.
Mr. L. Plewes, Wingfield Morris Hospital, Headington, Oxford.
Mr. I. S. Smillie, 1 Glencairn Crescent, Edinburgh, Scotland.
Mr. W. H. M. Smith, 33 Park Avenue, Portobello, Midlothian, Scotland.
Mr. V. C. Snell, Letchmore Heath, Watford, Herts.
Mr. Kenneth Stanger, Sydenham Terrace, Newcastle-on-Tyne.
Mr. G. E. Thomas, Royal Southern Hospital, Liverpool.

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In answer to inquiries in regard to physiotherapists, *The Journal* is glad to offer the following information:

The **American Physiotherapy Association** was organized at the close of the World War, its charter members being former Reconstruction Aides in service. One of its purposes is to "cooperate with and work only under the prescription of members of the medical profession". At present, it has a membership in excess of 800.

The requirements for membership, which have been approved by the Council on Medical Education and Hospitals of the American Medical Association, are: (1) an improved course in physical therapy of not less than nine months, following graduation from a school of nursing or physical education which meets the requirements of the individual states; (2) one year's practice in physical therapy within two years of graduation from an approved school of physical therapy. This standard enables the Association to provide to hospitals, schools for crippled children, and offices of physicians fully equipped and trained physiotherapists who are able to follow the physician's orders intelligently and thoroughly.

Those requiring this service should apply to the Secretary of the Association, Miss Edith Monro, 483 Beacon Street, Boston, Massachusetts.

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### Correction

In the article on "A Histopathological Study of the Synovial Membrane with Mucicarmine Staining" by James H. Cherry, M.D., and Ralph K. Ghormley, M.D., published in the previous issue of *The Journal* (Volume XX, page 48, January 1938), reference is made to the work of Dr. David H. Kling and also to that of Dr. E. S. J. King. The omission of the letter "l" in the final proof of this paper not only causes confusion, but also robs Dr. Kling of the acknowledgment of his work which the authors intended to make.

The first sentence of the second full paragraph on page 49 should read: "In 1931, Kling investigated the synovial fluid from the standpoint of viscosity and colloidal phenomena and was able to extract the mucinous substances."

and nutritional disturbances as causative factors is discredited. Instead, the various deformities are shown to be embryonic in origin with definite hereditary tendencies. What we call malformations are really only variations from usual form. A slight increase or diminution of certain components is common; a gross change, rare.

Classification of deformities is made according to developmental factors as follows:

1. Abnormalities of the anlage of the skeleton.
    a. Numerical variations.
    b. Disturbances of length differentiation.
2. Malformation on the basis of disturbance of the primitive hand plate.
    a. Disturbed development of breadth (syndactylia).
    b. Congenital defects of the primitive hand plate (claw-hand).
    c. Hyperplasia of the primitive soft-tissue plate (localized gigantism).
3. Congenital disturbances of the later development of the hands.
    a. Disturbances of the growth in thickness.
    b. Disturbances of the later growth in length.
    c. Exostoses and enchondromata.
    d. Osteochondritic changes.

The monograph is well illustrated by charts, line drawings, photographs, and roentgenograms. There is an extensive bibliography which includes mostly the German literature, however, and omits such names as Kanavel. It is a reference work which should be available to everyone interested in orthopaedic or plastic surgery.

TEXTBOOK OF EXPERIMENTAL SURGERY. J. Markowitz, M. B. (Tor.), Ph.D., M.S. in Exp. Surg. (Minn.). Baltimore, William Wood & Co., 1937. $7.00.

This pleasingly edited textbook presents in 527 pages and 330 illustrations the operative technique of various procedures in experimental surgery employed by the author at the Institute of Experimental Medicine of The Mayo Foundation. He states that the procedures described, although not inclusive of all that are excellent, will be more or less standard procedures in the broad field of experimental medicine. Laboratory experimentation has become an indispensable factor in the progress of further developments in the field of surgery. The part played by laboratory study in graduate teaching in surgery increases in importance yearly. These two facts alone would justify the existence of a book which records with meticulous care the paths to be followed by both the student and the surgeon in their quest for truth and knowledge.

There is much in the book which the surgeon, as well as the student, may read with profit and to which he should give careful thought. When surgeons are as well informed about physiology as they are about pathology and anatomy, there will be less aimless therapy in such supposedly well-understood conditions as peritonitis, intestinal obstruction, and ascites. The text on these conditions is not only highly informative, but it also stimulates the reader to seek the truth for himself. Provided such experimentation is carried out in proper laboratories, in conjunction with the clinical material available in a teaching hospital, only good can result.

It is obvious that only a small part of surgery can be attained in the lecture room. Skill is due largely to repetition and to experience. Much that is to be learned can be accomplished only through the opportunities provided in the experimental laboratory. To the individual entering the experimental field, this book will be invaluable; to the experienced, although he may in some instances cherish his own pet procedures, it will prove a worthy adjunct. The illustrations and bibliography alone, were they the only virtues, would merit a stamp of approval for this textbook of experimental surgery.

TRAUMATISMES DU PIED ET RAYONS X. MALLÉOLES, ASTRAGALE, CALCANÉUM, AVANT-PIED. Étienne Destot. Ed. 2. Paris, Masson et Cie, 1937. 45 francs.

This second edition of Étienne Destot's work on the importance of the roentgen ray in the treatment of injuries of the foot and ankle has been completed by two of his former

istic appearance. In these conditions, a definite conclusion of hernia cannot be reached except when the defect shown by the lipiodol is seen opposite a narrowed intervertebral disc.

7. The fact of the existence of one or more nuclear herniae does not signify any relationship between the hernia and the eventual static or nerve syndrome. This must necessarily be established by a comparison of the roentgenographic and clinical findings. If the roentgenographic findings do not present the necessary neurological evidence, a competent neurologist should be consulted.

The book is evidently the result of long experience and careful study of this subject which is comparatively new and on which much of the information has been more or less fragmentary. In addition to his own extensive experience, the author has reviewed the work and opinions of others and has put the subject on a much more definite basis. He has, in particular, contributed to the knowledge which will enable a more accurate diagnosis of hernia, and has done much to disprove the frequent statement that these herniae cannot be determined with any surety *in vivo*.

CHARTERHOUSE RHEUMATISM CLINIC ORIGINAL PAPERS. Vol. I. New York, Oxford University Press, 1937. $6.75.

The first paper, by Dr. Crowe, takes up the pathogen-selective culture of infective organisms in chronic rheumatic diseases, using a modification of the original Solis-Cohen technique. This procedure unquestionably has very considerable value in determining immunological resistance to an infecting organism, but we feel that there is a fallacy in the technique, as lack of resistance to a pathogen does not necessarily prove infectivity.

The classification used is a rather complicated one but seems, in the main, to be based on sound principles, and the subpatellar crepitus, which Crowe stresses, is unquestionably a valuable diagnostic sign.

The second paper, by Harry Coke, on the differential sedimentation test is an attempt to show the value of the procedure, both as a diagnostic test and as an index to success of treatment. The principle is based on the fact that serum is a colloidal solution, the major constituents being serum albumin and serum globulin. In the presence of a flocculating substance, the solution can be precipitated, depending on (1) the pH volume of the menstruum, (2) the action of the flocculent matter, and (3) the composition of the serum. The albumin-globulin ratio is altered in certain pathological states and especially in infections. In the ordinary sedimentation test, red blood cells are used as the flocculent material, but, in the differential sedimentation, vanadic acid is employed and there occurs precipitation by the colloidal solution carrying a negative charge in acid and a positive charge in an alkaline medium. Since the globulins are more easily neutralized and precipitated than the albumins, the albumin-globulin ratio furnishes an index in pathological conditions. The test would seem to be well worth further investigation.

S. Gilbert Scott's report on spondylitis adolescens with associated pathological changes in the sacro-iliac joints is an interesting one, showing that sacro-ilitis is the first roentgenographically demonstrable symptom of spondylitis adolescens. The actual roentgenograms, which the reviewer had the opportunity of examining, show the existence of this condition much more clearly than is demonstrated by the small reproductions in the book. It would appear that this finding is of distinct value as an early diagnostic sign.

DIE ANGEBORENEN FEHLBILDUNGEN DER MENSCHLICHEN HAND (The Congenital Malformations of the Human Hand). Prof. Walther Müller. Leipzig, Georg Thieme, 1937. 15.50 marks.

An orderly review of the entire subject of malformations of the hand is presented in this 160-page monograph in which emphasis is laid on the biological rather than the morphological aspects. The earlier concept of intra-uterine pressure, amniotic bands,

# ACUTE HEMATOGENOUS OSTEOMYELITIS *

BY D. E. ROBERTSON, M.D., TORONTO, ONTARIO, CANADA

The streptococcus and the staphylococcus are responsible for practically all of the cases of acute osteomyelitis. There is a difference in their ability to produce a fatal septicaemia, the streptococcus being responsible for 13.3 per cent. and the staphylococcus for 22.4 per cent. of the cases. There is very little similarity between the two conditions, and unless we make a clear-cut distinction between staphylococcal osteomyelitis and streptococcal osteomyelitis there cannot be any clear understanding of the serological problems that enter into the treatment of the condition. It is useless from the standpoint of treatment to group all cases of osteomyelitis and to consider the mortality of the whole group. (See Table I.) These diseases are entirely different in their clinical manifestations. The great outstanding difference is that there is no necrosis of bone in streptococcal infection, and in staphylococcal infection there is necrosis. In cases of streptococcal osteomyelitis, if drainage is done and if the patients recover, they will get well without the formation of sequestra. We have had no sequestrum occur in a surviving patient. Patients with staphylococcal osteomyelitis practically never get well without the formation of sequestra and are, therefore, more liable to become chronic cases. Forty-two per cent. of our patients under two years of age recovered, and of these 80 per cent. had sequestra. The staphylococcus in its growth produces an exotoxin, a diffusible substance that is excreted from the bacterium. Its potency is extraordinarily high, and its ability to cause necrosis is marked. The rate at which this toxin is produced is highest in the early life of the germ, as is demonstrated in the growing of cultures for the production of toxin. This difference in the two diseases is due entirely to the nature of the toxin produced by the infecting organism and the ability of the staphylococcus toxin to cause necrosis. Its power to cause serious change in the vascular system is the factor that makes staphylococcal osteomyelitis one of the most dreaded diseases occurring in the young. A child who has streptococcal osteomyelitis, if he survives the acute attack, is unlikely ever to have any recurrence or exacerbation. On the other hand, the child with staphylococcal osteomyelitis is liable to both of these contingencies.

Some years ago, in studying cases of staphylococcal osteomyelitis, a routine examination of the blood for its bacterial content was made. If the culture was made a number of times, organisms were grown in every case. Recently it has not been felt necessary to prove the presence of the organisms in every case or to follow out each day the number of colonies that will grow from a given amount of blood. It is obvious that, if the

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pupils, Dr. E. Gallois and Dr. P. Japiot. Prof. Destot's revision of the first edition was interrupted by the World War and his sudden death in 1918. The results of his remarkable studies and roentgenographic observations during the War have been included in this very thorough and painstaking revision of his original work.

Following the Preface by Dr. Alexis Carrel and Prof. Destot's Introduction, the anatomy and physiology of the foot and ankle are treated in great detail and with exceptional care. Each bone is accorded a full description of its surgical anatomy with special regard to its function and its articulations. Each aspect is considered in relation to the treatment of fractures and injuries.

The discussion of the fractures is grouped into three parts: first, those of the region of the malleolus; second, those of the posterior tarsus; and, third, those of the anterior tarsus. Each type is then considered with reference to its etiology, general symptoms, and roentgenographic appearance. Throughout this work special attention is given to the study of the roentgenograms and the interpretation of the evidence.

In the discussion of the posterior tarsus, the mechanical forces and stresses to which this part of the foot is subjected are considered, with particular emphasis on the influence of these forces on the etiology and treatment of fractures in this region. This is especially true with reference to fractures of the astragalus, which are often neglected because of the great attention paid to fractures of the calcaneum.

The lesions of the anterior tarsus are given little, but at the same time sufficient, space, for they do not play so important a part as the traumatic lesions occurring in the region of the malleolus, with which the book is mainly concerned

The book represents an extensive study of a closely localized area where many lesions occur which are severe in character and difficult to treat. The grouping of these aids in the study both of the etiology and of the treatment, and will be a valuable guide for those who are called upon to treat the traumatic lesions of this region.

A Practice of Orthopaedic Surgery. T. P. McMurray, M.B., M.Ch., F.R.C.S. (Edin.). Baltimore, William Wood & Co., 1937. $5.00.

In a text of 458 pages, Mr. McMurray has succeeded in covering all of the more common orthopaedic disabilities, with the exception of fractures. The book is written in a clear simple style, which holds the reader's attention. There is nothing of the statistical or laboratory approach to the problems discussed. The descriptions of the various entities are those of a practitioner of the art, and the methods of treatment are those which he has found useful. In the main, the teachings of Hugh Owen Thomas and Sir Robert Jones are strictly adhered to. The student and the younger orthopaedic surgeon who wish to know at first hand the teachings and practice of the "Liverpool School" will find this book a valuable source of information.

The illustrations are excellent. Photographs, roentgenograms, and line drawings are all used more profusely than is common in the smaller textbooks.

There are certain features of the book which are open to minor criticism. There is relatively too much space given to the discussion of bone and joint tuberculosis, at the expense of such important subjects as arthritis, disabilities of the low back, and anterior poliomyelitis. In the United States, at least, tuberculosis has ceased to be the subject of greatest importance to the orthopaedic surgeon.

Tendon transplantation in anterior poliomyelitis is a useful procedure in selected cases, particularly in helping to balance the muscle power in feet which require stabilization. The author's statement that transplantation of the peroneal tendon to the inner side of the foot to replace the action of a paralyzed tibial muscle "has been abandoned, as the result of such procedures was always unsatisfactory" comes as a surprise to this reviewer, who has seen many excellent results from peroneal transplantation, particularly if the foot has been stabilized by triple arthrodesis after the method of Hoke or of Dunn.

On the whole, Mr. McMurray's experience has enabled him to contribute a very readable and practical textbook on the subject of orthopaedic surgery.

DIAGNOSIS, COURSE, AND END RESULTS OF TUBERCULOUS SPONDYLITIS. Prof. S. W. Kofman. Tashkent, Committee of Sciences of the U. S. S. R., 1937.

This book, by a well-known Russian orthopaedic surgeon, presents valuable data, the result of observation for the past thirty years, and is based on material specifically studied within the period between 1924 and 1932 at the Odessa Tuberculous Institute. Three hundred and three cases thoroughly analyzed and followed up, including a great variety of pathological material, form the basis of the book. The discussion of symptomatology and treatment in the course of the development of the tuberculous disease of the spine shows an extensive experience. Prof. Kofman considers the surgical fixation of tuberculosis of the spine unsatisfactory. The best results are obtained by steady and prolonged heliotherapy combined with general treatment and fixation in appropriate apparatus. Guarded aspiration of abscesses and surgical treatment to relieve spasticity and other secondary deformities of the extremities are considered useful.

DIE VITAMINE IN DER CHIRURGIE (Vitamins in Surgery). Prof. Dr. Erich Schneider. (Vorträge aus der praktischen Chirurgie, 17. Heft.) Stuttgart, Ferdinand Enke, 1937. 3.50 marks.

This monograph deals with the leading vitamins and discusses surgical states associated with avitaminosis. Vitamin-A deficiency may be held responsible for epithelial damage in many organic systems. Its absorption from the alimentary tract is aided by the bile acids and its storage in the liver depends on an intact reticulo-endothelial system. Most animals can synthesize vitamin C from carbohydrates; only man, ape, and guinea-pig suffer from scurvy The daily requirement of vitamin C is higher than that of the other vitamins; little of it is stored, although its highest concentration is found in the adrenal cortex. Vitamin C is essential for the production of collagen and fibroblasts; it increases circulating thrombocytes and reticulocytes and the albumin-globulin ratio and helps to activate thrombin. Vitamin D promotes fracture healing only when this is delayed by a corresponding deficiency; it seems to act locally on individual cells. Vitamin $B_1$ is important to the function of the alimentary tract, and as an antineuritic factor is frequently useful in sciatica and occasionally in trigeminal neuralgia; it may have a value in bone regeneration.

There is a distinct difference between the minimal daily dose necessary to prevent deficiency symptoms and that required for optimum tissue conditions; this is particularly important when one considers the sparse storage of vitamin C and the four to six months' period of deficiency diet required to precede initial gingival bleeding. A valuable table of dosage is included.

Secondary hypovitaminosis is an invariable concomitant of inflammation. The loss of vitamin C is the most important; it results in poor tissue consistency and delayed wound healing. This deficiency is to be combated by the daily parenteral administration of 300 milligrams of ascorbic acid, usually requiring ten days to produce saturation. The marked loss of vitamin A in infections may further a terminal pneumonia. Vitamin A is necessary to an adequate function of the reticulo-endothelial system. Its deficiency is indicated by the presence of cornified epithelium in a corneal smear. Vitamins A and C definitely promote antibody formation, $B_1$ and D perhaps only indirectly. There is no danger of overdosage of vitamins A and C. Hypovitaminosis is frequently found in the presence of an apparently adequate diet.

The tissue friability found in cancer patients is an expression of vitamin-C deficiency.

Thyroid activity favors the effectiveness of vitamins. On the other hand, thyrotoxicosis diminishes the liver storage of glycogen, fat, and fatty acids, resisting a characteristic vitamin-A effect.

An immediate effect of surgical operations is to be found in the transient abnormal excretion of vitamin C induced by general anaesthesia. Deficient liver function following operation is often the result of vitamin-A loss. Preoperative parenteral administration of vitamin A increases liver glycogen and strengthens reticulo-endothelial activity;

vitamin C improves connective-tissue function, decreases capillary permeability, and supplies part of the cellular-energy requirement.

Body growth depletes the stores of vitamins A and D and increases the demand upon vitamin C. During body growth, defects in bone formation and development result from insufficient vitamins D and C. The florid stage of all the so-called osteochondritides shows a vitamin-A deficiency. Regression of these changes follows administration of sufficient vitamin A. Paget's osteodystrophia deformans is always accompanied by a vitamin-A deficiency; Recklinghausen's osteodystrophia fibrosa generalisata, by vitamin-C deficiency.

THE RÔLE OF CHEMIOTAXIS IN BONE GROWTH. A. P. Bertwistle, M.B., Ch.B., F.R.C.S. (Edin.). London, Henry Kimpton, 1937. 8 shillings, 6 pence.

In this monograph the author, whose admirable "Descriptive Atlas of Radiographs" is familiar to students of osteology, discusses the chief theories of ectopic bone formation. Under the caption of "disruptive chemiotaxis", he describes the process whereby certain hard substances, including bone, attract and draw into themselves certain soft, living structures, such as plant roots and connective tissue. On this basis, he explains the invasion of calcified material by young blood vessels and the relationship between calcification and ossification in normal bone, and accounts for the periosteal regeneration of bone after fractures and bone grafts. As a result of this discussion, he postulates the law that wherever a calcium deposit is in contact with young connective tissue, particularly young blood vessels, bone develops. The work is illustrated with thirty-two beautiful engravings and supported by a bibliography of seventy-five references.

Our impression is that in disruptive chemiotaxis the author has described a process which is new in its application to medicine, and which goes far to explain not only normal bone growth and repair, but phenomena hitherto misunderstood in bone pathology.

SCHMERZEN UND LEISTUNGSSTÖRUNGEN BEI ERKRANKUNGEN DER WIRBELSÄULE (Pain and Functional Disturbances in Affections of the Spine). Eduard Güntz. (Beilageheft zur Zeitschrift für Orthopädie. Bd. 67.) Stuttgart, Ferdinand Enke, 1937. 15.20 marks.

This monograph deals with the spine from the clinical standpoint as a living, kinetic structure, and in its relation to upright posture. It is based on affections which are regarded as having their primary seat in the intervertebral disc. Only secondary changes in the vertebral bodies permit recognition of these conditions during life. Such affections of the intervertebral discs do not in themselves cause pain. Pain arises through resulting disturbance of mobility or stability of the spine and represents abnormal demand on muscles and tendons. Many injuries of effort are due less to the effort than to preexisting functional or structural deficiency of the spine.

A practical, careful method of physical examination is discussed; difficulties in roentgenographic examination are enumerated; and many improvements in technique are described.

Güntz, a former pupil of Schmorl, accepts Schmorl's "cartilage-node" theory to explain the pathogenesis of juvenile kyphosis. The clinical description of this condition is good.

Emphasis is placed on the need of thinking of posterior prolapse of the nucleus pulposus in cases in which symptoms are referable to the sciatic nerve or to the lower spinal cord.

Tearing of the annulus lamellosus with anterolateral escape of portions of the intervertebral disc is accorded its due place in the genesis of spondylosis deformans (hypertrophic osteo-arthritis). In occasional cases of spondylosis of the cervical and fifth lumbar intervertebral discs, narrowing of the corresponding intervertebral foramina may result.

Osteochondrosis begins with yielding of the wall of the nuclear cavity and continues with degeneration, desiccation, and loss of height and elasticity of the disc, with extrusion and chondrification of disc tissue and even posterior displacement of a vertebral body. It is of frequent occurrence, usually related to trauma, and almost always accompanied by pain and stiffness in the distribution of the lower thoracic and lumbar spinal nerves.

The proper differentiation of senile kyphosis is especially important in legal medicine. A kyphotic posture over years results in the disintegration of the anterior portions of the intervertebral discs. This leads to stiffening of the spine and even to ossification between the anterior rims of the vertebral bodies.

L'ENCHEVILLEMENT CENTRAL DES FRACTURES DIAPHYSAIRES (Central Pegging of Diaphyseal Fractures). Paul-Louis Chigot. Paris, Masson et Cie, 1937. 25 francs.

Central pegging or intramedullary bone grafting was one of the first procedures used for osteosynthesis. However, following the introduction of osteosynthesis by means of metallic plates, intramedullary grafting gradually lost favor, because of technical difficulties and the fear of biological injury to the host. With the object of throwing some light on this subject, the author experimented with different types of intramedullary grafts. Without any effort to evaluate the osteogenetic value of such grafts, he concluded that:

1. Intramedullary grafts do not interfere with the vitality of the host.
2. They lead only to a transitory fibrosis of the medulla.
3. Callus forms well and os purum, described by Svante Orell, seems to be especially well adapted to this procedure.

Considerable space is devoted to the details of technique. In general, it is the author's opinion that the method should be employed in irreducible transverse fractures of the shaft of the humerus, the femur, the clavicle, the metacarpals, and both bones of the arm and the leg.

The monograph affords interesting information and will repay reading. Its value would undoubtedly be enhanced by a study of the osteogenetic value of these grafts. Unfortunately, this problem is purposely omitted. While the results in the author's hands are satisfactory, comparative statistics on the healing of similar fractures by other methods are not given. The question of pseudarthrosis and the value of the intramedullary graft in the treatment of this condition are not mentioned.

FRACTURES AND DISLOCATIONS FOR PRACTITIONERS. Edwin O. Geckeler, M.D. Baltimore, William Wood & Co., 1937. $4.00.

The attempt to condense into 250 pages the available information on fractures and dislocations without the omission of important details is a Herculean and an almost impossible task. The author has succeeded in giving an admirable bird's-eye view of the subject, but one wishes that he had not confined his treatment to such narrow limits. For example, fractures of the skull occupy twelve and one-half lines and at the conclusion of the eleventh line is this statement: "All cranial injuries are serious and their need of competent attention cannot be over-emphasized."

The illustrations throughout the book are excellent, and adequate references to articles and books are listed at the end of each division of the subject.

On the whole, this guide is sane and safe, and the reader is left with the feeling that he would like to visit the author's clinic and discuss many matters in regard to the treatment of fractures. A book of this kind is of more value to a practitioner who is mature than to a student who has yet to cover all the ground and then choose his policy and determine his detail.

ATLAS OF SKELETAL MATURATION. T. Wingate Todd, M.B., Ch.B., Manc.; F.R.C.S., Eng. St. Louis, The C. V. Mosby Company, 1937. $7.50.

In this unusual study the author has given under the term "maturation" the results

of extensive research on the development and growth of bone. He first states his conception of the significance of the term, its relation to the general growth and size of the individual, the disturbing influences in normal growth, etc. In the introductory portion of the book he discusses the subject in general, the establishment of standards, and the plan of investigation or study by which these results were obtained.

Part I, which concludes this first volume, is devoted to studies on the hand and the standards which cover the period of from three months to the age of sixteen years in girls and nineteen in boys, at which time the symbols or determinators of maturity cease to register the progress of this process. Observations at different periods of growth have been recorded, and a distinct series is given for boys and for girls so that a comparison between the two can be made. Each observation is illustrated by excellent roentgenograms, and the maturity determinators are listed with each. This comprises the description of the essential features of the bones in the hand as shown in the x-ray, with the special appearances which are presented by this means. In this way the changes can be followed and compared throughout the period of growth.

This work is in accord with the more advanced and accurate knowledge which the perfection and the accurate use of this laboratory equipment has allowed, and indicates the marked advance of this now necessary means of diagnosis. The lack of exact knowledge of normal standards has been a handicap in many cases requiring accurate study and fine differentiation. This book eliminates much of this lack in this special field.

SURGICAL DISEASES OF THE MOUTH AND JAWS. Earl Calvin Padgett, B.S., M.D., F.A.C.S. Philadelphia, W. B. Saunders Co., 1938. $10.00.

It does not seem possible that there can be as many diseases of the mouth and jaws as the author discusses in this very elaborate book. This textbook has been prepared for the dentist, the physician, and the oral surgeon, as well as dental and medical students. All of the subjects outlined by the Curriculum Committee of the American Association of Dental Schools in 1935 have been thoroughly covered.

A review of the anatomy in relation to examination and treatment is a great help in the chapters that follow. Several chapters are given up to injuries of the bony framework and particularly to fractures. The author discusses the underlying principles of the mechanism of fractures, the aids in diagnosis, the relationship of the teeth, care of the teeth, methods of reduction and fixation of the fractures, anaesthesia, and methods of feeding. A full chapter is accorded to dislocations of the jaw.

In order to review the book completely, it would be necessary to abstract all the chapters. Suffice it to say that neurological aspects, plastic surgery, benign and malignant tumors, the principles of irradiation for malignant tumors, the technique of operative treatment of neoplasms, the repair of congenital deformities such as cleft palate and harelip, and the surgical restoration of deformities are very completely discussed. The pathological changes are emphasized.

THE PHYSICIAN'S BUSINESS. PRACTICAL AND ECONOMIC ASPECTS OF MEDICINE. George D. Wolf, M.D. Foreword by Harold Rypins, A.B., M.D., F.A.C.P. Philadelphia, J. B. Lippincott Company, 1938. $5.00.

Like Dr. Hugh Cabot's "The Doctor's Bill", this book deals with the practical and economic aspects of medicine. In a series of chapters, the author discusses such matters as the choice of hospital internship, medical careers other than private practice, specialization, location, professional contacts, records, fees, office planning, equipment, personnel, prescribing, selection and care of instruments, forensic medicine, income tax, and professional insurance. Dr. Harold Rypins, in his admirable preface, points out how essential such practical details are in the pursuit of professional success. The book is illustrated with fifty-eight simple, but graphic, figures.

This book offers tangible correctives to the liability of many good physicians to be poor men of business, and combats the fallacy that good business is beneath the dignity

of the medical profession. We heartily commend it to the perusal and practical application of those who would succeed in medicine as fully as their professional attainments qualify them to do.

EIN BEITRAG ZUR BEHANDLUNG DER FRACTURA OSSIS NAVICULARIS CARPI (The Treatment of Fracture of the Carpal Navicular). Oscar Aleman. *Acta Chirurgica Scandinavica*, LXXX, 217, 1937.

Chiefly as the result of the work of Böhler and Schnek, the recognized treatment of fresh navicular fractures consists in prolonged immobilization. Total or partial extirpation of the fragments is to be deprecated. In frank non-unions the writer suggests removal of the smaller or the distal (when of equal size) fragment. Total excision is a mutilating procedure.

The writer's series comprises ninety-one cases over a twenty-year period with a follow-up in 94.5 per cent. The end results are analyzed in detail. Three were impacted fractures; nine were "marginal", as he calls those of the tuberosity; and seventy-nine were transverse or intra-articular.

In thirty-one fresh transverse fractures there were good results following cast fixation in 74 per cent. Extirpation of one fragment in twenty-four of the cases of non-union gave good results in 83 per cent. and fair results in 17 per cent.

In six cases of non-union the fragments were drilled and then immobilized in plaster for from six to twelve weeks; the results in these cases were all bad.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ON SECONDARY EPIPHYSEAL NECROSIS AFTER COLLUM FEMORIS FRACTURE IN YOUNG PERSONS. REPORT OF 2 CASES. Asger Naeraa. *Acta Chirurgica Scandinavica*, LXXX, 238, 1937.

Two original cases and fifteen from the literature are presented in a study of epiphyseal necrosis following fracture of the neck of the femur in young individuals. According to zur Verth, one-third of these fractures result in a deformity indistinguishable from coxa plana, occurring most commonly between the ages of fourteen and sixteen, but occasionally between eleven and seventeen. In contrast to older patients, in this age group fractures of the trochanter are particularly liable to lead to deformity. A review of the literature with regard to etiology leads the writer to conclude that the necrosis is due to tearing of the synovial capsule of the neck with injury of the blood vessels to the head. Later in life, a localized necrosis is more likely from such an impaired blood supply. Freedom from weight-bearing should be maintained while the process is active, and frequent reexamination is urged for at least a year after healing.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ÜBER DIE ENTWICKLUNG DES TUBERKULÖSEN PROZESSES UND DIE ENTSTEHUNG VERSCHIEDENER AUSHEILUNGSFORMEN BEI TUBERKULOSE DER WIRBELKÖRPER SOWIE EINIGE DAMIT ZUSAMMENHÄNGENDE VERHÄLTNISSE (The Development of the Tuberculous Process and the Occurrence of Different Types of Healing in Tuberculosis of the Vertebral Bodies). Arvid Hellstadius. *Acta Orthopaedica Scandinavica*, VIII, 1, 1937.

Previous classifications of vertebral tuberculosis are first reviewed. After a study of 614 cases over a four-year period, the writer discusses the material under nine headings. The work is actually a monograph of 180 pages, with excellent x-ray reproductions, tables, and charts.

The mechanism of localization of the process and its development in various parts of the vertebral body are outlined. The occasional increase in density about a tuberculous focus is not due in most cases to compression of the trabeculae or to caseation. This perifocal increase in calcium seems to be a response to toxins elaborated by the

tubercle bacillus. Extension of a tuberculous process over intervertebral discs and subperiosteally along the bodies to cause extensive destruction without multiple implantation may be followed in serial roentgenograms. Even isolated central involvement may occur by posterior subperiosteal extension with invasion through the vascular channels. This may occur as a secondary process in a succession of bodies with definite calcification of the tuberculous tissue indicating the course.

With reference to healing, the following lesions are distinguished:

A. Paradiscal
   1. Circumscribed lesion in contact with the disc.
   2. Involvement of the entire contiguous surface.
B. Spondylitis visible only as a diminution of the intervertebral disc.
C. Extensive destruction.
D. Central spondylitis.
E. Vesicular spondylitis.
F. Anterior, posterior, and lateral spondylitis.
G. Spondylitis with diffuse osteoplastic changes.

Distribution of these types of lesions is charted for various age groups and for different levels of the spine. In cases of multiple involvement with lesions of the D, E, and F types, there was a tendency to reduplication of the same type of lesion.

Paradiscal lesions and healing by bridge formation are relatively infrequent in the first ten years of life. Healing by block formation is no less frequent under the age of ten. Spastic paralysis, associated with extensive destruction, often occurs in this age group.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

MYALGIA EPIDEMICA IM KINDESALTER (Epidemic Myalgia in Children). Gustaf Lindberg. *Acta Paediatrica*, XIX, 1, 1937.

Lindberg reviews the previous reports of epidemic myalgia in Sweden and records his own observations of an epidemic of myalgia in the fall of 1934, in which eighty children were attacked. Most of the cases occurred during the month of September. The incidence was greatest at the age of seven. Seventy patients were under twelve years of age. Pain appeared without prodromes except slight malaise, usually in the chest or abdomen, occasionally in the neck or arms. The pain was severe in character. In twenty-five cases there was swelling of the musculature. In a number of the patients intrathoracic or intra-abdominal lesions were suspected. In most instances there was a mild leukopenia, in a few a leukocytosis of 12,000. The blood-sedimentation rate was followed in twenty-three patients. In these a mild increase in the blood-sedimentation rate was observed during the course of the disease. A meningitis with increased pressure of the spinal fluid, positive Pandy test, and increased cellular content were noticed in five cases. All of these patients recovered promptly. The duration of symptoms was usually four or five days. No microscopic examination of the muscles was made, nor could the author find any record of any pathological study in the literature. The author believes that the disease is an acute infectious process which spreads much like influenza. The only treatment was symptomatic. All of the patients recovered completely.—*John G. Kuhns, M.D., Boston, Massachusetts.*

BEITRAG ZUR KENNTNIS DER "PERITENDINITIS CALCAREA" (SOGEN. "BURSITIS CALCULOSA") SPEZIELL VOM PATHOLOGISCH-HISTOLOGISCHEN GESICHTSPUNKT. [A Contribution to the Knowledge of Peritendinitis Calcaria (So-Called "Bursitis Calculosa") from the Histopathological Viewpoint.] Carl Sandström und Fredrik Wahlgren. *Acta Radiologica*, XVIII, 263, 1937.

The roentgenographic, operative, and pathological studies of twelve cases of peritendinitis calcaria, involving the shoulder, the hip, the knee, and the ankle, are reported. Calcium deposits were found in the tendons, the capsule, and the periosteum.

Microscopically the deposition of calcium seemed to be secondary to necrosis or necrobiotic lesions. Since the arterial branches showed thickening of the media or narrowing of the lumina, the authors regard the necrosis as being due to vascular disturbance. Morphologically the picture is one of chronic inflammation.

The etiology is discussed, but no positive statement is made on this point.—*A. R. Smith, M.D., Iowa City, Iowa.*

LIFE EXPECTANCY AND INCIDENCE OF MALIGNANT DISEASE. V. MALIGNANT LYMPHOMA, FIBROSARCOMA, MALIGNANT MELANOMA, AND OSTEOGENIC SARCOMA. Ira T. Nathanson and Claude E. Welch. *The American Journal of Cancer*, XXXI, 598, 1937.

This is the fifth in a series of papers by these authors dealing with the life expectancy and incidence of malignant disease of various regions. The authors have analyzed the material available at the Huntington Memorial Hospital and Pondville Hospital, including 161 cases of fibrosarcoma and eighty-one cases of osteogenic sarcoma. Graphs are presented showing the life expectancy of patients with these diseases as compared with the normal life expectancy of the age group. Statistical studies have been made of the age and sex incidence. The median age of the fibrosarcoma group was forty-one years, that for the osteogenic-sarcoma group was twenty-five years. The median life expectancy after onset was forty-three months in fibrosarcoma and twenty-one months in osteogenic sarcoma. Five years after onset death has occurred in 58 per cent. of the fibrosarcoma cases and in 85 per cent. of the cases of osteogenic sarcoma.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

OSTEITIS DEFORMANS (PAGET'S DISEASE). FISSURE FRACTURES—THEIR ETIOLOGY AND CLINICAL SIGNIFICANCE. M. Lowry Allen and Rutherford L. John. *The American Journal of Roentgenology and Radium Therapy*, XXXVIII, 109, 1937.

The authors believe that roentgenologists and surgeons in general are quite unfamiliar with the entity of these fissure fractures in Paget's disease, as well as their clinical significance. They state that the literature contains little on this condition and that there is a lack of observation of such cases over a prolonged period.

It is the authors' opinion that fissure fractures occurring in Paget's disease are due to slight trauma; hence, they may be regarded as incomplete pathological fractures. The authors believe that such fractures are responsible for the lengthening of the involved bone. These fractures generally heal with minimum amount of callus formation, which assumes the characteristics of the dominant Paget's disease. However, with slight trauma, they may go on to complete fracture which is characteristically transverse.

Four cases are described in which typical Paget's disease was present and fissure fractures in the cortex of the convex surface of the bone appeared. In two of the cases these fissures became complete transverse fractures, due to local trauma. Union occurred in both cases.—*R. M. Wray, M.D., Iowa City, Iowa.*

IDIOPATHIC FAMILIAL GENERALIZED OSTEOPHYTOSIS. Ernst Freund. *The American Journal of Roentgenology and Radium Therapy*, XXXIX, 216, Feb. 1938.

The author states that the case which he describes, aside from its unusual individual manifestations involving gigantic deformities of the extremities, has great importance from a theoretical viewpoint. It represents a condition which, at first, entails difficulties of differentiation,—whether it be an aborted form of acromegaly, or a hypertrophic osteo-arthropathy, or whether it is altogether in a class by itself.

The patient was a man, fifty-seven years old, who, at the age of fourteen, following an attack of measles, had begun to show swelling and tenderness in the fingers. The con-

dition had progressed steadily and extensively, apparently with periods of exacerbation. Often in the springtime the manifestations recurred and the hands and feet became enlarged to the proportions of gigantism. The condition gradually increased until it resulted in the patient's relinquishing his vocation of farming. It affected different parts of the body, and the enlargement was prodigious, particularly below the knees. Also affected at times were the ligamentous structures.

The author gives a very thorough description of the changes and distribution in this case, which evidently was one of extreme degree and allowed opportunity for thorough study.

The question of classification of this case is discussed thoroughly and the author refers especially to the normal state of the intrathoracic viscera observed clinically and roentgenographically, and to the long duration of the malady, affording opportunity for the development of the periosteal bone production found. He rules out the ordinary case of Bamberger-Marie osteo-arthropathy, but considers the fact that there are a number of cases wherein hypertrophic osteo-arthropathies give no evidence of any metapneumopathic cause and others in which the bone changes are not associated with arthritis. The author is inclined to accept Crump's suggestion that the term "*ostéoarthropathie hypertrophiante pneumonique*" (Marie) be omitted, and that the term "generalized osteophytosis" be substituted. Under this heading he classifies the case which he describes. He mentions the lack of familial occurrence in this case, but believes it to be a point of only relative significance, since the patient had only half-brothers on his mother's side and knew nothing of his father. He feels that this point of the family history is of interest in dealing with a constitutional disease, the disposition to which is transmitted by the father alone, the children of the mother by another man being normal.—*Percy Brown, M.D., Boston, Massachusetts.*

Osteomyelitis in Children. Frank R. Ober. *American Journal of Surgery*, XXXIX, 319, Feb. 1938.

The etiology, pathology, bacteriology, and roentgenographic appearance of the different types of osteomyelitis are discussed, and the management of each type is given.

Acute osteomyelitis is a different problem in children under two years of age, probably due to differences in the character of the bone. The streptococcus is the predominating organism. Sequestrum formation is rare. In acute osteomyelitis in children over two years of age, the staphylococcus is the predominant organism. Sequestrum formation is the rule. In acute cases without severe constitutional symptoms, the local process is an emergency problem. However, the desperately ill child in poor physical condition is treated systemically until his condition permits simple drainage. A marked reduction in mortality has been obtained by following this rule.

Chronic osteomyelitis is divided into three groups: (1) sclerosing osteomyelitis; (2) Brodie's abscess; (3) chronic osteomyelitis following the acute type. The author suggests a non-weight-bearing splint for any case of chronic active osteomyelitis of the lower extremity.

Infrequent dressing of wounds in all types is recommended. The skin wound must be kept open as widely as possible until the cavity in the bone is well filled with firm, granulating tissue. Early skin healing favors retention of discharging products, delaying bone healing.—*O. Anderson Engh, M.D., Washington, D. C.*

Fractures and Dislocations Involving the Elbow Joint in Children. D. E. Robertson. *American Journal of Surgery*, XXXIX, 327, Feb. 1938.

Fractures of the elbow region are classified into those involving: (1) the supracondyle; (2) the lateral condyle; (3) the mesial epicondyle; (4) the olecranon; (5) the head and neck of the radius; and (6) the ulna (in its proximal half) with dislocation of the head of the radius. The diagnosis and special treatment for each type are given. Careful

examination of the arm for interference with function of nerves or blood vessels is stressed to prevent malpractice suits. Closed reduction should be accomplished as soon as possible after the accident. In the presence of shock, gross deformity should be diminished. Open operation is often necessary to fix the fragments in accurate position. The use of screws or fine dowels of boiled beef bone is recommended for fixation. The need of close observance of the limb distal to the fracture for two days following reduction is stressed. Morphine should not be administered following a reduction without first ascertaining complete blood supply and normal motion of the hand and fingers. Proper roentgenograms and perfect reduction in fractures involving articular surfaces are important.—*O. Anderson Engh, M.D., Washington, D. C.*

Compound Fractures in Childhood. Fenwick Beekman. *American Journal of Surgery*, XXXIX, 312, Feb. 1938.

The author stresses the importance of conservative judgment. Hasty decisions of a radical nature may result in the loss of a limb or even in the death of the patient. Injuries in children offer more chance for eventual improvement than in adults. Deformities and poor function benefit by age and adaptation. Reconstruction operations some years later may return the part almost to normal. Amputation, unless absolutely necessary, is advised against.

The automobile has produced compound injuries from without in contrast to the compounding from within, which was formerly the case. Efficient splinting, prevention of further contamination, and early traction are recommended. The importance of adequate cleansing is stressed. Satisfactory reduction at the first attempt is necessary, for manipulation at a later date diffuses infection. Infrequent dressing of wounds and early immobilization are advocated. The fractures and wounds of severe crushing injuries are best treated by traction and suspension, immobilizing the part, restoring alignment and length to the bone, and obliterating dead spaces by stretching and pulling muscles into their original position. Early skin grafts lessen scar tissue and contracture. —*O. Anderson Engh, M.D., Washington, D. C.*

Primary Bone Tumors in Children. Bradley L. Coley and Richard L. Peterson. *American Journal of Surgery*, XXXIX, 334, Feb. 1938.

Early recognition of primary bone tumors in children lies in the field of paediatrics and of orthopaedic surgery. Primary malignant tumors of bone are most frequently observed in children and in young adults. This is especially true of Ewing's sarcoma and osteogenic sarcoma. The tendency to consider the symptoms as rheumatic or neuritic is an obstacle to early diagnosis. The failure to take roentgenograms early is also responsible for error in diagnosis. Pain, in the absence of signs of infection, should arouse suspicion. The location of a tumor is a valuable guide in determining the type. The services of a well-trained roentgenologist are indispensable for arriving at a diagnosis and assisting in treatment. The pathologist is also an invaluable member. The importance of phosphatase, calcium, and phosphorous determinations and of the aspiration biopsy is mentioned. Irradiation, resection, amputation, and the use of Coley's mixed toxins in the treatment of the various bone tumors are discussed. Irradiation and surgery in the same case are inadvisable. It is hoped that the advances in diagnosis of malignant bone lesions, made in the last two decades, will be duplicated by advances in treatment.—*O. Anderson Engh, M.D., Washington, D. C.*

Relation between Tuberculin Allergy and Clinical Course. J. M. Appel, B. H. Douglas, T. R. Joez, and H. S. Willis. *The American Review of Tuberculosis*, XXXVI, 303, 1937.

Tuberculin sensitiveness fluctuates, but not closely in accord with changes in the patient's clinical condition. From the evidence at hand it would seem that no definite

conclusions can be drawn between tuberculin sensitiveness and the clinical course. Therefore, the degree of reaction to the tuberculin test is no indication of the amount of clinical disease.—*Clarence A. Ryan, M.D., Vancouver, B. C., Canada.*

A New Administrative Technique in Tuberculosis Case-Finding. Bruce H. Douglas and Henry F. Vaughn. *The American Review of Tuberculosis*, XXXVI, 325, 1937.

This is a brief presentation of the plan now being initiated in Detroit and Wayne County for the detection of tuberculosis. The basis of this plan is the general practitioner who is paid by the Health Department the sum of one dollar for tuberculin testing, and one dollar for the final consultation of positive reactors. Where x-rays are necessary (that is in all positive reactors) the private x-ray laboratory may undertake such work at a fee of three dollars, or the patient may be referred to the Health Department for such examination. Follow-up work is under the Department of Health, but any diagnosis or advice to the patient is given by the general practitioner after consultation with the Department of Health staff. This removes any possibility of the patient's being "scared" by being informed of his diagnosis by someone with whom he has not had any former contact. While the experience under this plan has been of very short duration, it indicates that the plan offers great promise of success in finding cases early.—*Clarence A. Ryan, M.D., Vancouver, B. C. Canada.*

La artrorrisis posterior del pie (Posterior Arthroereisis of the Foot). Oscar R. Marottoli. *Anales de Cirugia*, III, 84, 1937.

The special technique which the author advocates is based upon the insertion of a free graft as described by Camera. A U-shaped incision is made in the retromalleolar region, extending from the inferior portion of the metaphysis of the tibia and the malleolus toward the external border of the foot in the direction of the cuboid. The tendons of the peronei are separated and retracted to one side, and the tendo achillis and the flexor hallucis longus are exposed. An arthrotomy, exposing the articular surface of the astragalus, is then performed.

From the external surface of the external malleolus a bone graft—four centimeters long, one and one-half centimeters wide, and about one centimeter thick—is recovered. The foot is then placed in the necessary position of dorsiflexion, so that the posterior portion of the cartilaginous surface of the astragalar body comes into view. A cuneiform trough is made and in this bed the peroneal graft is inserted with light taps of a hammer. This graft extends out for a distance of one or two centimeters in order to form a buttress against the posterior tibial surface. The author believes that it is preferable to insert a large graft in the oblique, upward, and forward direction, so that it may become better solidified with the substance of the astragalus.

The foot is immobilized in the position of correction in a plaster cast. In cases of flexion contracture, the lengthening of the tendo achillis precedes the insertion of the bone graft. *A. Steindler, M.D., Iowa City, Iowa.*

Rupture of the Supraspinatus Tendon. T. Wallis Davis and John E. Sullivan. *Annals of Surgery*, CVI, 1059, 1937.

During 1936 the authors saw five cases of complete rupture of the supraspinatus tendon, all within seventeen days following injury. They discuss briefly the anatomical relations of the muscle and call attention to the fact that rupture of the tendon usually occurs in men past middle life. All of their cases occurred in the sixth decade of life. These patients were all muscular men who had performed hard manual labor for many years, which bears out the theory that age and occupation produce pathological changes in the tendon that predispose it to rupture.

In four cases operated on within two weeks of the injury the tendon was ruptured immediately proximal to its insertion. In three of these there was blood-tinged joint fluid in the subacromial bursa.

Codman lists eighteen conditions which are associated with complete rupture. Two of the authors' cases examined within twenty-four hours presented all of these conditions,—namely, hard manual labor; over forty years of age; no symptoms prior to the accident; adequate injury, usually a fall; immediate sharp brief pain; severe pain the following night; loss of power of elevation of the arm; negative roentgenogram; little, if any, restriction when stooping; faulty scapulohumeral rhythm,—a tender point, a sulcus, and an eminence at the insertion of the supraspinatus, which causes a jog, a wince, and soft crepitus as the tuberosity disappears under the acromium when the arm is elevated and usually, also, as it reappears during descent of the arm. In the authors' cases pain was the most variable symptom.

In the authors' five cases the tendon was sutured to the greater tuberosity by means of drill holes, and the ends of the tendon were sewed together with silk sutures. The authors believe that suture of the tendon is the only form of treatment, and that it should be carried out immediately. In their four cases operated on within thirteen days there was very little retraction of the tendon. The postoperative treatment consisted of immobilization in abduction and external rotation for two or three weeks.—*O. B. Bolibaugh, M.D., San Francisco, California.*

INTERNAL FIXATION FOR RECENT FRACTURES OF THE NECK OF THE FEMUR. Melvin S. Henderson. *Annals of Surgery*, CVII, 132, Jan. 1938.

In a rather complete review of the subject, the author states that experience at The Mayo Clinic has showed that the risk of operative treatment is no greater than that of conservative treatment, provided operation is performed ten days or longer after injury.

Operative treatment promises a better chance for a good result than conservative treatment.

The author applies traction to the extremity immediately after the injury as preliminary treatment before operation. Pain is controlled by traction and by administration of opiates.

The operative treatment eliminates the need of prolonged confinement in a plaster spica and obviates the sequelae of stiff knees and hips.

The author reviews the various methods of internal fixation, the development of the cannulated nail and lag screw, and points out the technical difficulties of the operation and the importance of roentgenographic control with anteroposterior and lateral views. He describes in considerable detail the lag screw developed at The Mayo Clinic and compares its relative merits with the Smith-Petersen nail.

Fourteen days after the operation, motion of the hip and knee can be safely started. This is carried out by means of an overhead suspension apparatus which can be operated by the patient. Union cannot be expected under ninety days. Weight-bearing must be delayed for at least six months.

Henderson next discusses the results in fourteen cases operated on more than a year ago in which the condition of the patients is known. Bony union and excellent function were obtained in 86 per cent. of the cases. No serious infection occurred. Drainage followed late in two cases. There were no deaths from operation, and convalescence was much more satisfactory than by the conservative method.—*O. B. Bolibaugh, M.D., San Francisco, California.*

TEARS OF THE SUPRASPINATUS TENDON. RÉSUMÉ OF TWELVE OPERATED CASES. Tom A. Outland and Walter F. Shepherd. *Annals of Surgery*, CVII, 116, Jan. 1938.

Since 1934 the authors have seen fourteen cases and have operated on twelve, at which time the lesion was demonstrated and the tendon was repaired. Between 1928

TABLE I

ANALYSIS OF CASES OF OSTEOMYELITIS SEEN AT THE HOSPITAL FOR SICK CHILDREN, TORONTO, FROM 1923 TO 1936

| | *No. of Cases* | *No. of Deaths* | *Per Cent.* |
|---|---|---|---|
| **A. Entire Group** | | | |
| Staphylococcal | 277 | 62 | 22.38 |
| Streptococcal | 60 | 8 | 13.33 |
| Total | 337 | 70 | 20.77 |
| **B. Patients Under Two Years** | | | |
| Staphylococcal | 24 | 14 | 58.33 |
| Streptococcal | 22 | 4 | 18.18 |
| **C. Patients Over Two Years** | | | |
| Staphylococcal | 253 | 48 | 18.97 |
| Streptococcal | 38 | 4 | 10.52 |
| **D. Patients with Staphylococcal Osteomyelitis** | | | |
| Prior to use of antitoxin | 183 | 41 | 22.40 |
| Since use of antitoxin | 94 | 20 | 21.27 |

disease becomes general from a local lesion in the skin, or the gastro-intestinal tract, or elsewhere, it must find its way by the blood to a bone. Whether twenty or twenty million organisms invade the blood stream may make no difference to the individual whose natural resistance is of a degree sufficient to combat the infection. This natural resistance appears to consist of at least two known agents,—one is the natural antitoxin that neutralizes or renders inert the toxin produced by the organism, and the other has to do with the destruction of the organism by phagocytosis. The former, the natural antitoxin, is very important, as the intoxication from the staphylococcus has a peculiarly destructive power for vascular tissue. It has three toxins,—leukocytolysins, hemolysins, and necrotizing toxins. These toxins, if given in pure form in an experimental animal, may cause death in a few minutes. The presence of these toxins may stimulate the human organism to the production of antitoxin, and, if the intoxication is not too severe, a high level of production of antitoxin may spontaneously be reached.

In addition to the antitoxic property of the blood, there may be another, known as the opsonic action,[9] which is said to prepare the bacteria for ingestion, and it is possible that there is something inherent in the bacterium which has to do with stimulation of phagocytosis. No attempt has been made in this series of cases to show the opsonic indices of the patients, nor has any attempt been made to study the cases according to the differentiation of the white cells (the Arneth formula).

THE NICOLA OPERATION FOR RECURRENT DISLOCATION OF THE SHOULDER. Harry Koster. *Archives of Surgery*, XXXVI, 61, Jan. 1938.

In a rather short but clear article Koster describes the Nicola operation for recurrent dislocation of the shoulder. He emphasizes the importance of firm fixation of the tendon in the tunnel through which it is passed. He also stresses the desirability of the Z-shaped incision to the small transverse section of the tendon. Three cases are reported.—*I. William Nachlas, M.D., Baltimore, Maryland.*

SPEICHENBRÜCHE DES ERWACHSENEN AN TYPISCHER STELLE (Fractures of the Radius at Typical Sites). Hans Kotrnetz und Fritz Geiringer. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVII, 504, 1937.

Since 1928, at Denks Clinic in Vienna, a total of 873 cases of radial fractures at the wrist have been treated by the Böhler method of reposition under local anaesthesia and fixation in unpadded plaster casts. Certain modifications are practised,—notably delayed reduction of most fractures. Unless marked displacement is present, the fracture is kept splinted for at least twenty-four hours before reduction is performed. According to the authors, the delay permits swelling to reach a maximum before the cast is applied.

At the time of local anaesthesia through the dorsum (the hematoma remains fluid) an additional infiltration of the ulnar-styloid region is performed.

Reduction by traction without violence is practised, attempts at anatomical reposition being stressed. A circular cast is applied.

Circulatory disturbances are carefully watched for. (In one of two early cases in which the casts were not split promptly, an ulnar palsy developed, which remained permanently.) In eighty-five cases the plaster had to be split. The cast is left on from three to five weeks, union and painless function in the cast comprising the indications for its removal. Non-union of the ulnar styloid occurred in 152 of 248 cases. Dorsal subluxation of the ulna was observed in twenty-six and volar subluxation in nine of the cases reexamined. The authors agree with others that longer fixation in a long arm plaster is indicated, but are skeptical about 100-per-cent. results.

Good cosmetic and functional results were obtained, if there existed no tendency to axial shifting. When a tendency to shortening of the radius appeared, good function, but a worse cosmetic result, was obtained. While ideal anatomical reposition is aimed at, it is not an absolute necessity for a good functional result. On the contrary, excellent repositions (in the roentgenogram) were not always associated with corresponding function.

Attempts at reposition after eight to fourteen days delay healing about two weeks, and tend to increase circulatory disturbances.

Seven types of fractures about the wrist are listed. The patients with severe intra-articular fractures were well in general in twelve weeks, while those with transverse fractures were well in from seven to nine weeks.—*J. E. Milgram, M.D., New York, N. Y.*

ÜBER DIE PSEUDARTHROSE DES OS NAVICULARE MANUS (Concerning Pseudarthrosis of the Carpal Navicular). I. Boerema. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVIII, 42, 1937.

The author reports a group of thirty-six fractures. Six of these were old and in each case the ulnar fragment had been removed more than ten years previously. About half of the remainder, early cases, had been treated by mobilizing methods. The other half, recent cases, were treated by immobilization in ulnar adduction according to Böhler.

Of seventeen patients with pseudarthroses, who were reexamined, fifteen had limitation of volar and, especially, of dorsal flexion up to 50 per cent. of that of the normal hand. Two had a normal range. Seven of the patients were obliged, because of pain on use, to seek a less arduous occupation. Two patients, despite pseudarthroses, suffered in no way, as far as work was concerned. Limitation of motion bore no relation to disability. In short, objective signs were no measure for subjective complaints.

and 1934 they diagnosed only three such cases, which now leads them to believe that they failed to recognize the condition.

Rupture of the supraspinatus tendon is due to trauma, either from a fall with the arm suddenly abducted to break the fall or by direct blow (or fall) on the back of the shoulder. Predisposing causes are age and an existing pathological condition of the tendon.

Rupture takes place at or near the greater tuberosity. There is frequently associated a tear in the floor of the bursa, producing a direct communication with the joint.

The authors emphasize the following points in diagnosis:

1. Diminution or loss of the power of abduction.
2. Tenderness over the greater tuberosity.
3. Undue prominence of the greater tuberosity.
4. Crepitus of a fine nature over the tuberosity as it moves under the acromion on passive movement of the arm.

The authors advocate suture of the tendon unless the tear is very small, in which case rest in abduction is indicated.

In the recent cases, the tendon is sutured with two or three heavy mattress sutures. In the older cases, scar tissue is excised from the edges of the tendon before suturing. When there is insufficient tendon attached to the tuberosity, the proximal end of the tendon is anchored in a groove in the tuberosity by means of silk sutures passed through drill holes.

The postoperative treatment consists of immobilization by use of an axillary pad, sling, and bandage. When the wound is healed, sinusoidal current and "bending" exercises are given. At the end of three weeks, assisted active and other exercises are started.

Of the twelve patients operated upon, the results were excellent in four, good in four, fair in three, and poor in one.—*O. B. Bolibaugh, M.D., San Francisco, California.*

RATIONALE OF BONE DRILLING IN DELAYED AND UNUNITED FRACTURES. Proviso V. Prewitt and E. R. Easton. *Annals of Surgery*, CVII, 303, Feb. 1938.

In discussing the subject of osteogenesis in fracture repair, following the drilling operation, the authors evaluate the following aspects: (1) skeletal maturity; (2) effect of local environmental biophysical states upon bone production; (3) normal bone, a balanced physiological mechanism; and (4) possible physiological effects from the drilling operation.

The authors report fourteen cases of delayed union or non-union that were successfully treated by this method.

The drilling operation is indicated in cases in which: (1) one of the opposing fragments is viable; (2) there is potentially adequate arterial blood supply in one of the fragments; (3) the distance between the fragments is not too great to be spanned by a reasonable amount of new bone.

The authors conclude that bone regeneration following the drilling operation results from enrichment of the local circulation, stimulation of bone cells along the drill canals to renewed activity, and the elaboration of calcium and phosphorus conjugating enzymes necessary in the formation of bony callus.—*O. B. Bolibaugh, M.D., San Francisco, California.*

PRODUCTION OF OSTEOSARCOMA IN A MOUSE BY THE INTRAMEDULLARY INJECTION OF 1, 2-BENZPYRENE. A. Brunschwig and A. D. Bissell. *Archives of Surgery*, XXXVI, 53, Jan. 1938.

Brunschwig and Bissell report the experimental production of bone-forming sarcomata in rats following the intramedullary introduction of carcinogenic chemicals. They believe that this is the first instance of the experimental production of an osteosarcoma by a chemical agent. The chemicals used were 1, 2-benzpyrene and cholesterol.—*I. William Nachlas, M.D., Baltimore, Maryland.*

fitting; (3) the capsule should not be stripped too much; (4) the operation should not be performed on a limb that is greatly deformed; (5) there must be good circulation about the joint; (6) the function of the muscles should be good.

The principle feature of the technique of arthroplasty is the interposition of material to prevent contact, preferably a double layer of autogenous fascia lata or a pedicle flap of muscle, fat and fascia, chromicized pig bladder or ox fascia. Trauma should be avoided as much as possible. Hemorrhage may be controlled by an Esmarch bandage and hemostasis. For the incision at the hip, the half U or anterior Smith-Petersen incision should be used. It is important to have a capacious acetabulum and a snugly fitting capsule. At the knee, the incisions recommended are: the bilateral (Baer), the curved lateral (Campbell), the inverted Y (Putti), or the median-patellar (Kleinberg). Postoperative care is most important. Immobilization should be maintained for a minimum of two weeks. To obtain traction, a spica is applied with the limb flexed and the hip in 10 degrees of flexion and 25 degrees of abduction. At the end of the second or third week, the spica is removed and the limb is placed in a balanced swinging apparatus (a Thomas splint or plaster posterior shell).—*E. F. Case, M.D., Iowa City, Iowa.*

La trazione scheletrica agli arti inferiori nelle complicanze paralitiche delle fratture e lussazioni vertebrali (Skeletal Traction on Lower Extremities in Paralytic Complications of Vertebral Fractures and Dislocations). Antonio Poli. *Archivio di Ortopedia*, LIII, 79, 1937.

Poli describes the method of treatment of lesions of the vertebral spine with involvement of the spinal cord as he observed it at Böhler's Clinic. To prevent decubital ulcers on sacrum and heels, or to treat such ulcers more easily once they have developed, both lower extremities are placed on Braun's splints, and skeletal traction is applied through the tibial tubercles. The patient is able to raise himself with the arms, which facilitates the bathing of the patient and the making of the bed. Physical therapy is more easily applied.—*Ernst Freund, M.D., Los Angeles, California.*

Lussazione congenita dell'anca (Congenital Dislocation of the Hip Joint). Antonio Poli. *Archivio di Ortopedia*, LIII, 3, 1937.

The author has presented a statistical study from the *Pio Istituto dei Rachitici di Milano*, based on 8,610 cases observed from 1903 to 1936, including 12,105 deformities, the richest material ever investigated in one clinic.

Congenital dislocation of the hip joint is more frequently found in the female (84.36 per cent.) than in the male (14.64 per cent.). The dislocation is more frequently unilateral (60.89 per cent.) than bilateral (39.11 per cent.). The left side is more often affected (16.98 per cent.) than the right (13.91 per cent.). Bilateral dislocation occurs more often in the female (39.87 per cent.) than in the male (35.03 per cent.). Unilateral dislocation is more frequent in males (64.97 per cent.) than in females (60.13 per cent.). Congenital subluxation is more common in the female than in the male. Subluxation is more often unilateral (97.39 per cent.) than bilateral (2.61 per cent.). The condition was hereditary in 7.57 per cent. of the cases. Paternal transmission is more frequent (1.72 per cent.) than maternal (1.36 per cent.). The deformity was familial in 18.75 per cent. The deformity was noticed in 7,064 cases when the child started to walk (89.51 per cent.); in 493 cases at the time of birth or within the first months of life (6.31 per cent.); in 320 cases during the first year of life (4.06 per cent.). The ages of the patients at the time of admission were from one to three years in 5,419 cases (64.30 per cent.); in 1,881 cases, from three to six years (22.81 per cent.); in 569 cases, from six to ten years (6.87 per cent.). The average age of the patients decreased during the period from 1931 to 1936 to twenty months, as compared with four years during the period from 1903 to 1905.

Treatment consisted of the reduction manoeuver of Paci-Lorenz in 7,561 cases, open reduction in thirty-four cases, palliative surgical treatment in 360 cases, and bloodless palliative procedures in 519 cases.

The author takes issue with Böhler's absolutely favorable prognosis in this fracture (100-per-cent. union reported in 150 fresh cases). However, he is in favor of this type of treatment.

He reports five cases of spontaneous union without treatment of any sort, and shows the roentgenograms in each case. Three of these were cases of incomplete fracture.

Of the six patients in whom the ulnar fragment had been removed prior to development of arthritic changes, all but one were able to resume full use of the hand, a matter of much surprise to the examiner.—*J. E. Milgram, M.D., New York, N. Y.*

NERVENSCHÄDIGUNGEN DURCH INTRAMUSKULÄRE INJEKTIONEN (Nerve Injuries through Intramuscular Injections). H. Demme. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVIII, 205, 1937.

Aside from the general toxic effect of injected protoplasmic poisons, local nerve lesions resulting from intramuscular injections are not very rare. Such extremity palsies, especially of the radial nerve, have been repeatedly reported. The author observed the appearance of paralysis of the extensor indicis proprius following a quinine injection into the extensor aspect of the forearm. For this reason, intramuscular injections had best be confined to the glutei and, indeed, as the old rule states, only to the upper outer quadrants of the glutei.

The author reports five cases of injury to the sciatic nerve after intragluteal injections. The drug was quinine in three cases, chlorcalcium in two cases. Motor (mainly peroneal), sensory, and occasionally trophic changes, usually permanent, followed. Characteristic was the appearance of severe pain as the immediate sequela of the injection. In one case the material passed up the sciatic-nerve sheath to the spinal ganglia. Animal injections corroborate the possibility of this occurrence.—*J. E. Milgram, M.D., New York, N. Y.*

ZUR PATHOLOGIE UND BEHANDLUNG DER PERONEUSSEHNENLUXATION (Pathology and Treatment of Dislocated Peroneal Tendons). Joh. Volkmann. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVIII, 262, 1937.

The author refutes the common concept of a widened sheath with a subluxated tendon lying anterior to its normal groove. In his experience, the tendon sheath is torn as is the upper restraining band. The anterior origin of the sheath is also torn loose, often with a roentgenographically demonstrable fragment of bone, leaving the bone of the groove bare.

Through an adequate incision, the author replaces tendon and sheath into the grooves, fastening the sheath with two or three sutures passed through drill holes if necessary. The anterior flap of the tendon sheath is brought over the posterior and fastened for reenforcement. The restraining bands need not be reconstructed.

Three cases in working men have been operated upon successfully. The longest postoperative period is three years.—*J. E. Milgram, M.D., New York, N. Y.*

ARTHROPLASTY IN THE LOWER EXTREMITY. Samuel Kleinberg. *Archives of Surgery*, XXXIV, 1072, 1937.

The object of this operation is the establishment of useful motion in ankylosed joints or the increase of existing motion. It is not probable that 100-per-cent. motion will be obtained. Cases of traumatic origin are the most favorable; those with rheumatoid arthritis, eburnation of bone, or fibrosis of the muscles are the most unfavorable. The patient must desire the operation, and should be between twenty and forty-five years of age, in good general condition, free of infection, and not too stout. His social and financial position must also be considered.

The principles governing the procedure are as follows: (1) Enough bone should be removed to ensure easy motion; (2) the articular surfaces should be smooth and well

may have stronger ligaments than normal, especially between the fibula and the tibia, and these fibers may be responsible for the lesion. Roentgenographic examination is absolutely necessary in any knee-joint lesion, because such small fractures may remain unrecognized clinically and lead to the erroneous diagnosis of sprain. The treatment consists in the application of an elastic bandage.—*Ernst Freund, M.D., Los Angeles, California.*

LA FRACTURA DEL CUELLO FEMORAL DEL ANCIANO (Fracture of the Neck of the Femur in the Aged). Herman De Las Casas. *Boletin de los Hospitales*, XXXV, 591, 1937.

The author classifies fractures of the neck of the femur as "internal" and "external" fractures. The point of division is where the internal vessels (from the capsular ligament and synovia) reach the neck of the femur, about one centimeter from the edge of the head. This classification has a physiological basis, because, in the internal fractures, the head of the femur, without enough blood supply, becomes necrosed.

The treatment varies according to the general condition of the patient.

In the case of an internal fracture, if the patient is a poor risk, extirpation of the fractured head is done, without any other procedure. If the patient is a good risk, a subtrochanteric osteotomy is also done. The upper fragment is placed in adduction and the lower one in abduction, the result being an angle on the external surface. By this procedure, the shortening of the femur and the insufficiency of the gluteal muscles are corrected.

In the case of an external fracture, if the patient is a poor risk, an osteosynthesis is done, using a Sven Johansson nail. If the patient is a good risk, a bone graft, taken from the tibia, is used instead of a nail. With a special instrument, a cylindrical form is given to the graft.

When only the extirpation of the head of the femur is done, the result is claudication, because of the shortening of the femur and insufficiency of the gluteal muscles. With the other operations, the functional result is good. The author considers the bone graft better than the nail because he has found a good deal of rarefaction of the bone in contact with the nail. — *Abraham Schwartz, M.D., Santiago, Chile.*

THE SUPERVENTION OF OSTEOGENIC SARCOMA IN PAGET'S DISEASE. T. B. Davie and W. E. Cooke. *The British Journal of Surgery*, XXV, 299, 1937.

"Two cases are described of multicentric foci of osteogenic sarcoma arising in patients suffering from Paget's disease (osteitis deformans). The features of this 'Paget's sarcoma' are discussed in the light of information obtainable from a review of the literature. The features particularly studied are: the aetiological relationship of sarcoma to the coincident Paget's disease; the sex and age incidence; the time factor in the development of the sarcoma; the sites of election of the sarcoma; the multicentricity of foci in these growths; the microscopical features; coincident changes in other organs and tissues; views as to the aetiology of Paget's disease; the nature of the initiating stimulus resulting in sarcomatous change; prognosis and treatment.

"The conclusions drawn from these considerations are that Paget's disease predisposes affected bones to sarcomatous changes, and that this malignant supervention arises at sites of stress in those bones showing advanced changes of osteitis deformans, possibly as the result of the stimulus of a super-added endocrine disturbance."

TWO CASES OF DIAPHYSIAL ACLASIS SHOWING SARCOMATOUS CHANGE. E. K. Gardner. *The British Journal of Surgery*, XXV, 323, 1937.

Diaphyseal aclasis is the name given to a hereditary condition exhibiting multiple exostoses. Keith has stated that he believes this to be due to an arrest of periosteal extension at the ends of the diaphysis. It must be distinguished from dyschondroplasia which is characterized by the presence of masses of endosteal cartilage in the metaphyseal regions.

The late results were good in about 52 per cent. of the cases. In unilateral cases with an observation time of under five years the results were good in 71.82 per cent.; in bilateral cases good results were obtained in only 40.26 per cent. With an observation period of more than five years, the results in unilateral cases were good in 61.16 per cent., in bilateral cases, in 38.85 per cent. In the treatment of patients during the first year of life, results obtained by simple immobilization in abduction were excellent in 92 per cent. Results by open reduction were good in only 20 per cent. of the cases when treated after the age of five, in 32 per cent. when treated younger.—*Ernst Freund, M.D., Los Angeles, California.*

SULLA COSIDETTA EPICONDILITE OMERALE (The So-Called Epicondylitis of the Humerus). A. Mastromarino. *Archivio di Ortopedia*, LIII, 133, 1937.

The author has studied three cases of his own and the quite extensive bibliography on the subject. He mentions all the different factors which have been considered of etiological importance and feels very sure that muscles play the only significant part. Anatomical and functional investigations revealed that it is the common extensor of the fingers which is responsible for the pain. There are certain anatomical peculiarities around the insertion of this muscle or the epicondyle, which, together with an unusual structure of the dense muscle fascia, lead to a critical functional stage. Morphological variations of the skeleton may aid in bringing about a painful condition of the elbow. The muscle undergoes pathological changes under the influence of prolonged forceful action, either by faulty mechanics of the muscle or by impaired circulation which changes the biochemistry of the muscle tissue. Histological specimens removed from two cases were entirely negative for alterations of the periosteum or of the bone. There were changes in the muscle tissue in the sense of a chronic inflammatory process.

As far as treatment is concerned, the author is in full agreement with Hohmann and strongly recommends surgical intervention. He does not believe that conservative treatment can give lasting results.—*Ernst Freund, M.D., Los Angeles, California.*

SULLA LUSSAZIONE ABITUALE DI SPALLA (Habitual Dislocation of the Shoulder). Aldo Fiorentini. *Archivio di Ortopedia*, LIII, 171, 1937.

After a complete review of the clinical picture, etiology, pathological anatomy, pathogenesis, and treatment of habitual dislocation of the shoulder, eight cases are reported in which the operation of Cattaneo was performed. The results were uniformly excellent. The technique consists in a suspension of the head of the humerus with fascia lata. The strip of fascia is passed below the neck of the humerus, and the ends are united tightly over the acromion. A plaster-of-Paris cast is applied in abduction.—*Ernst Freund, M.D., Los Angeles, California.*

LA TRAPANAZIONE OSSEA NEL TRATTAMENTO DEL MORBO DI PERTHES (Bone Drilling in the Treatment of Perthes' Disease). Antonio Poli. *Archivio di Ortopedia*, LIII, 215, 1937.

On a basis of five cases, the author demonstrates that multiple drilling of the epiphyseal line is of beneficial influence on the clinical course of Perthes' disease. The duration of the disease is shortened and repair is hastened.—*Ernst Freund, M.D., Los Angeles, California.*

LA FRATTURA PARCELLARE DELL'EPIFISI SUPERIORE ESTERNA DELLA TIBIA (Chip Fracture of the Upper Outer Epiphysis of the Tibia). Lodovico Armani. *Archivio di Ortopedia*, LIII, 241, 1937.

Three cases of chip fractures at the upper outer epiphysis of the tibia are described. They occurred during strenuous gymnastic exercise. The author thinks that sportsmen

returned to their old occupations, and very few complained of any discomfort. A few patients were treated by arthrodesis and two by Böhler's skeletal traction. The results were not as good as in those cases treated by the simpler method.

The writer doubts that the usual causes for poor results—spur formation, loss of the arch, excessive bone below the external malleolus, etc.—are really factors at all. He believes that the arthritis of the subastragalar joint is the common cause of poor results.

He believes that the simpler treatment is the best and advocates non-interference. Freedom from weight-bearing for three months with the foot in plaster, followed by active use with massage and assisted movements, and manipulation under anaesthesia two or three months later, is the course advocated. He quotes one insurance company executive as regretting treatment for this condition by an orthopaedic surgeon but advocating the simpler treatment by the patient's own doctor.

TREATMENT OF SPASTIC PARALYSIS. F. H. Mills. *British Medical Journal*, II, 414, 1937.

The treatment outlined by the author was developed more than twenty years ago during the War in the course of work done on soldiers convalescing from cerebrospinal meningitis. Since that time, only the more severe spastic cases have been treated,—for example, those suffering from cerebral diplegia or Little's disease and, more recently, the spastic cases resulting from post-thrombotic paralyses.

In discussing the various etiological factors, the author emphasizes that many of the patients when first seen appear to be idiots. After treatment only four patients have had to be rejected as true idiots.

The author particularly stresses the pronounced degree of associated sensory disturbance in these patients. It is manifested in various ways such as loss of appreciation of relative intensity of different stimuli, or of appreciation of spatial relationship, and interference with the interpretation of proprioceptive impulses, especially in the smaller joints, is often noted. All the phenomena of incoordination are for the most part of sensory origin, and educative therapy must also have a sensory basis. Therefore, treatment resolves itself into inhibition of the motor spasm followed by an intensive sensory and, to a lesser extent, motor education. Motor education must follow the sensory.

Inhibition of muscle spasm is the first essential in treatment. This is initially accomplished by use of the warm bath (37 degrees centigrade) to promote relaxation of the spastic muscles, and at the same time these affected muscles are gently manipulated. Muscle groups are treated proximodistally in succession until they relax. Such stimuli cause a state of inhibition of the spasm and what is termed the "inhibitory after-period" develops, which, in turn, is gradually extended as treatment proceeds and generally becomes permanent,—that is, conditioned. As found in Pavlov's experiments, the inhibition will readily spread,—for example, if the muscles of the face are inhibited, dribbling of saliva will cease and often incontinence of bladder and rectum will be controlled. At no time are rhythmic movements or quick cyclic movements attempted.

Deformities yield to stretching by special apparatus once inhibition of muscle spasm has been effected. Stretching should never exceed half an hour each day and should not cause pain. In only three of the 370 cases was tenotomy required. Ramisectomy now has no part in the treatment of spastic paralysis; in fact, in the author's experience, it is often harmful. Likewise, it is believed that Stoffel's operation is contra-indicated, as following this procedure the paralyzed parts of the muscle later become fibrosed and retract and spasticity returns.

The author stresses the fact that the cases treated along the lines described have been of the most severe type of spasticity. The treatment obviously requires energy, enthusiasm, and the maintenance of a cheerful outlook. —*G. E. Haggart, M.D., Boston, Massachusetts.*

The writer cites two cases of malignant changes,—namely, the formation of a locally malignant cartilaginous neoplasm in such a process. Both cases showed a sudden increase in size in a known exostosis. Radical operation is indicated.

FRACTURES OF THE SHAFT OF THE FEMUR. A NEW METHOD OF TRACTION AND IMMOBILIZATION. Eric L. Farquharson. *The British Journal of Surgery*, XXV, 592, Jan. 1938.

A Kirschner wire is passed through the lower end of the femur. A portable traction table with a screw traction device is used. Reduction is accomplished with both the hip and the knee flexed. A tensometer spring is included in the line of pull to measure the amount of pull being used, which may be as high as ninety pounds before reduction is obtained.

After reduction, a full-length unpadded plaster casing, in some instances with the addition of a spica, is applied with the traction still in effect. After the plaster is dry, the pull is reduced to fifteen or twenty pounds in the line of the femur. By an ingenious use of loops made in the plaster, the leg is suspended over an overhead pulley. Traction is maintained for four or five weeks.

INTERLOCKED ARTICULAR PROCESSES COMPLICATING FRACTURE-DISLOCATION OF THE SPINE. A SURVEY OF SOME RECENT CASES TREATED BY OPEN OPERATION. Alan H. G. Munro. *The British Journal of Surgery*, XXV, 621, Jan. 1938.

Three cases of fracture-dislocation of the spine with paraplegia are cited. In all of these there was transposition of the intact articular processes. Reduction by manipulation is impossible in this type of case, and manipulation may do harm to the already damaged cord.

Early open operation is advised. In order to aid in manipulation through the open wound, spats attached to a rope and pulley-block are secured to the patient's feet. At open operation, it is easy to reduce the fracture. Improvement is reported in two cases, and there was no change in one.

FRACTURED LUMBAR SPINE WITH UNILATERAL DISLOCATION. A. Wilfrid Adams. *The British Journal of Surgery*, XXV, 632, Jan. 1938.

A boy of seventeen was injured by falling under a bus. Roentgenograms showed a deformity of the fourth lumbar vertebra, with a displacement of the spine forward and with angulation in the anteroposterior view. There were also fractures of the first four right transverse processes.

Closed manipulation was unsatisfactory and open operation was done four days later. The spinous processes of the third and fourth lumbar vertebrae were fractured. The superior articular facet of the fifth lumbar vertebra was bare on the right side, while the inferior articular process of the fourth had jumped over it and was deep to it. The lamina of this vertebra lay obliquely astride the upper edge of the fifth. By hyperextending the pelvis on the spine and by using a bone lever, the displacement was corrected. Recovery was complete.

FRACTURE OF THE OS CALCIS. W. J. Eastwood. *The British Journal of Surgery*, XXV, 636, Jan. 1938.

Forty-seven cases, with a total of fifty-three fractures, are reviewed. Forty-seven fractures were treated by simple immobilization with preservation of the arch by plaster, but with no attempt to restore the normal alignment. Eighty per cent. of the patients

TABLE II

STAPHYLOCOCCUS TITERS OF 120 NORMAL FEMALES

| Age of Subject | Range of Titers | Average Titer |
|---|---|---|
| 6 months | 0.1 – 1.2 | 0.59 |
| 1 year | 0.2 – 1.0 | 0.6 |
| 2 years | 0.3 – 0.8 | 0.53 |
| 3 years | 0.3 | 0.3 |
| 4 years | 0.2 – 0.75 | 0.43 |
| 5 years | 0.8 – 1.8 | 1.1 |
| 6 years | 0.3 – 2.8 | 1.1 |
| 7 years | 0.2 – 1.8 | 0.64 |
| 8 years | 0.2 – 1.8 | 1.1 |
| 9 years | 0.1 – 0.6 | 0.4 |
| 10 years | 0.1 – 1.5 | 0.5 |
| 11 years | 0.2 – 1.8 | 0.6 |
| 12 years | 0.2 – 1.7 | 0.8 |
| 13 years | 0.1 – 1.8 | 0.47 |
| 14 years | 1.0 – 3.6 | 1.6 |
| 15 years | 0.3 | 0.3 |
| 20 to 30 years | 0.09 – 1.8 | 0.83 |
| 30 to 40 years | 0.6 – 1.8 | 1.2 |

It is known that the antitoxin of the blood may be definitely measured,[3] and it is now spoken of in terms of antihemolytic units.

Before one may speak of the titer of an individual who is suffering from a disease, the common range of titers in apparent health and in known disease should be determined. Therefore, 305 individuals in apparently normal health, ranging in age from six months to forty years,

TABLE III

STAPHYLOCOCCUS TITERS OF 185 NORMAL MALES

| Age of Subject | Range of Titers | Average Titer |
|---|---|---|
| 6 months | 0.27 – 1.25 | 0.59 |
| 1 year | 0.2 | 0.2 |
| 2 years | 0.2 – 0.5 | 0.35 |
| 3 years | 0.2 – 2.2 | 0.73 |
| 4 years | 0.1 – 2.8 | 0.79 |
| 5 years | 0.1 – 1.8 | 0.62 |
| 6 years | 0.2 – 1.7 | 0.9 |
| 7 years | 0.2 – 1.7 | 0.6 |
| 8 years | 0.2 – 1.7 | 0.7 |
| 9 years | 0.2 – 1.8 | 0.88 |
| 10 years | 0.1 – 2.2 | 0.88 |
| 11 years | 0.1 – 1.8 | 0.6 |
| 12 years | 0.1 – 1.8 | 0.5 |
| 13 years | 0.2 – 2.2 | 0.86 |
| 14 years | 0.6 – 2.4 | 1.4 |
| 15 years | 0.5 – 0.6 | 0 5 |
| 20 to 30 years | 0.6 – 1.8 | 0 97 |

TUMORS OF BONE. RESPONSIBILITIES OF THE PATHOLOGIST. J. S. Young. *British Medical Journal*, II, 647, 1937.

The author advocates that, following every amputation of a limb for bone tumor or while performing every post-mortem examination in which a deep-seated or inaccessible bone tumor is present, the pathologist should bisect the bone containing the lesion at right angles to the plane of the best roentgenogram available, or in such other plane as will best facilitate the interpretation of the roentgenogram. After determination of the histological structure and classification of the growth, then the roentgenologist and the pathologist, together with the surgeon, should correlate the macroscopic and microscopic appearance of the growth with the roentgenogram. The preparation of giant sections of the whole tumor or segment thereof is likewise particularly stressed for the purpose of correlating roentgenology with pathology.

A detailed discussion regarding the advisability of biopsy is given, with the conclusion that an open biopsy is not lethal; in fact, the author believes that, in view of Wood's experiment on rat sarcoma and rat carcinoma, an open biopsy may not even be dangerous. The method of Hoffman—that is, puncture of the bone sarcoma by a wide-bore needle attached to a twenty-cubic-centimeter syringe—is definitely condemned.

The article concludes with the following suggestions:

1. In every surgically accessible and radio-apparent bone lesion which might conceivably be bone sarcoma, decompression by open operation should be carried out as soon as possible.

2. At this operation a piece of tissue, large enough to be considered a fair sample of the lesion, should be excised for microscopic examination. This process should be repeated if the pathological report is not conclusive.

3. If the lesion is proved to be a bone sarcoma, amputation or wide resection should be carried out immediately, or, if the lesion is not a bone sarcoma, other appropriate measures should be instituted.—*G. E. Haggart, M.D., Boston, Massachusetts.*

ZUR KLINIK UND PATHOLOGIE DER SYNOVIOME (Clinical and Pathological Aspects of Synovioma). A. Fehr. *Bruns' Beiträge zur klinischen Chirurgie*, CLXV, 88, 1937.

The author adds four more cases of synovial sarcoma to the seventeen previously reported in the literature. Photographs and histological sections are well reproduced.

The author stresses the slow but sure malignancy of the lesion. He emphasizes the difficulty often encountered in the pathological identification of the synovial origin. Clefts in the tissue early in tumor history usually enable recognition of the tissue of origin. Late sections may reveal purely sarcomatous structure.

In early cases, where feasible, he advises wide excision with the diathermy knife. If this cannot be accomplished with certainty, or if the lesion has recurred, amputation must be performed.

When metastasis occurs, the lungs are most often involved. The regional lymph nodes are next often the site of tumor involvement.—*J. E. Milgram, M.D., New York, N. Y.*

BEITRAG ZUR KENNTNIS DER PRIMÄREN MUSKELTUBERKULOSE (A Contribution to the Knowledge of Primary Muscle Tuberculosis). Shunro Kushizaki und Kunio Saito. *Bruns' Beiträge zur klinischen Chirurgie*, CLXV, 177, 1937.

The authors report two cases,—one in a male, twenty-four years old, and the other in a female, thirty-four years old. In the first case, the lesion was solitary, involving the pectoralis major. In the second case, there were multiple lesions, and almost symmetrical masses were present in the four extremities. This case also presented calcified hilus nodes.

These masses are difficult to diagnose clinically, since they move with the muscle, and they are smooth and usually tender. The overlying skin is not involved. Radical excision is advised.

The authors list the varieties of pathological changes reported in the literature as nodular, abscess type, and fungoid-sclerosing. Half of the cases reported were of the abscess type. The multiple-lesion type, seen by the authors, showed fungoid-sclerosing lesions and is most rare.

Pathological identification usually is essential to diagnosis, since the masses grossly resemble tumors, parasitic infestation, and chronic specific inflammatory lesions.

The more recent literature is carefully analyzed, and colored plates of the operative findings in their two cases are reproduced.—*J. E. Milgram, M.D., New York, N. Y.*

ENDSCHICKSALE VON KRANKEN MIT GELENKNAHEN TUBERKULÖSEN KNOCHENHERDEN UND GROSSEN TUBERKULÖSEN SEQUESTERN (End Results in Cases of Tuberculous Osseous Foci near Joints and with Large Tuberculous Sequestra). H. Nase. *Bruns' Beiträge zur klinischen Chirurgie,* CLXV, 572, 1937.

An analysis of thirty-three cases treated conservatively and thirty-three cases treated by surgical excision enables the author to draw indications for treatment. From one-half to two-thirds of all tuberculous lesions rupture from a bony focus into the neighboring joint. The surgeon's problem is to minimize this joint involvement. These cases were followed for varying periods ranging from five to fifteen years. Small numbers of cases appear in each group. In general, conservative therapy, when successful, obtained healing in an average of fifteen months. In 45 per cent., fistulae or abscesses developed. Of seventeen cases of lesions of the long bones, treated by surgical extirpation of the focus, twelve healed. The average time of healing in the surgically treated cases was seven months.

In general, the local tuberculous lesions, if in the short bones of the extremities, or if inaccessible to surgery, or if epiphyseal damage threatens in children, had best be treated conservatively. Conservative therapy is also advised in dubious cases in the upper extremity, since strain from weight-bearing does not exist here.

Operative therapy is advised for patients of all ages if the lesions are in the long bones in the neighborhood of the larger joints. Local excision of the focus helps the general resistance in cases where generalized infection exists.—*J. E. Milgram, M.D., New York, N. Y.*

ZUR BEHANDLUNG DER TRAUMATISCHEN SYMPHYSENRUPTUR (Treatment of Traumatic Rupture of the Symphysis). Gustav Sommer. *Bruns' Beiträge zur klinischen Chirurgie,* CLXV, 607, 1937.

Four cases of symphysial separation treated by pelvic compression (two in a sling, one operatively, and the fourth in a sling supported by an overhead frame) are reported. The author finds that the displacement is readily corrected conservatively. Good results were obtained in three cases. One patient died of a massive pulmonary embolus two months after injury. Post-mortem examination revealed thrombosis of the left femoral vein at the level of Poupart's ligament as the cause of the embolism. The symphysis in this case was one centimeter wide and filled with fibrous tissue. The original diastasis had amounted to six centimeters.

In the one case operated upon, wire fixation was employed. Suppuration developed, necessitating removal of the wire. The patient walked three months after injury with less than one centimeter of residual separation.

In one case hematuria persisted for several days, but with spontaneous micturition, indicating an injury to the pars membranacea or a mild bladder injury.—*J. E. Milgram, M.D., New York, N. Y.*

RÉFLEXIONS À PROPOS DE LA RÉSECTION DE LA HANCHE (Resection of the Hip). Jean Verbrugge. *Bulletin de la Société Belge d'Orthopédie,* IX, 115, 1937.

The author advocates resection of the hip in cases of painful deformation of the hip as in those of arthritis deformans. He is convinced that the pain is due to the lesion of the

hip joint itself, not to muscle spasm. The subcapital fracture is the only one for which there is as yet no definitely satisfactory method of treatment; at the present time Whitman's plastic reconstruction is the only method which affords an opportunity for healing, but it is difficult and involves the risk of pseudarthrosis.

The femoral head should never be resected without liberation of the gluteus medius and lowering of the greater trochanter upon the femur. The resection of the hip should never be attempted without careful exposure, and the head should never be sectioned until the hip has been dislocated out of the cotyloid cavity.

An incision is made at the greater trochanter from the anterior superior spine, in the furrow between the anterior border of the gluteus medius and posterior border of the tensor fascia, extending downward to the interior aspect of the greater trochanter and across to the external surface of the femur. The femoral aponeurosis is then carefully incised in the same line between the two muscles; the muscles are separated downward to the base of the greater trochanter and upward one or two centimeters above the anterior superior spine. The loose tissue which covers the articular capsule is then directly exposed. The deep fibers of the gluteus medius can easily be resected by inserting the spatula under the muscle and outlining the greater trochanter. The latter is sectioned at its base or somewhat lower and isolated at its posterior aspect from the pelvic trochanteric muscles. The surgeon then works upward to the acetabular cavity, exposing the neck and head at the cotyloid rim. It will be found that the ankylosis is never complete, and, with the help of a large spoon, one is able to penetrate into the acetabulum, the entire surface of which can be uncovered by the cutting of the round ligament, with the limb in adduction, flexion, and forced external rotation. It is then possible, by a few taps with the chisel, to liberate the head from the neck at its base. The borders of the neck are then rounded off, and the neck is replaced.

For the lowering of the greater trochanter, the limb is placed in forced abduction, if the gluteus medius has been well liberated at its lower extremity and the greater trochanter has been sectioned low enough. The upper end of the vastus externus is then sectioned longitudinally, the upper surface is exposed and freshened, and the greater trochanter is nailed in its new position by a long, boiled-bone nail inserted obliquely from below upward for the entire thickness of the femur. There is no drainage, and a plaster-of-Paris cast is applied.

Recently, the author has placed the patient in bed without a cast and has simply immobilized the limb in strong abduction with sand bags. After eight days, passive mobilization is begun, followed by active mobilization in three weeks. The patient sits up during the fourth week, remains up after five weeks, and is permitted to walk after the sixth week.

The author has treated fifteen cases by this method and has obtained good results in all. The pain has definitely disappeared; the patients have begun to walk at the end of the second month; and the shortening has varied between three and five centimeters. The mobility depends upon the deformation of the cotyloid cavity; it is always about 25 per cent. less than normal.—*Arthur Steindler, M.D., Iowa City, Iowa.*

PATHOGÉNIE ET TRAITEMENT DU GENOU EN FLEXION (Report on the Pathogenesis and Treatment of Flexion Contracture of the Knee). M. Soeur et L. Ronse. *Bulletin de la Société Belge d'Orthopédie*, IX, 176, 1937.

Scars, due to burns, infections, aponeurotic lacerations, tendon injuries, metastatic abscesses, tuberculous fistulae, congenital intra-uterine ulcerations, and ankylosis following purulent processes, arthritis, or osteomyelitis, are etiological factors. The authors also discuss extra-articular and intra-articular blocks due to habitual luxation of the patella, semilunar dislocations, condylar lesions, meniscus cysts, joint mice, tears of the cruciate ligaments, synovial fringes, chondromatosis, exostoses, and flexion following juxta-epiphyseal osteomyelitis and gonorrhoeal arthritis. In the chronic arthritides, retraction of the posterior capsule and synovial adhesions play an important rôle. Con-

tractures resulting from diseases of the nervous system, myositis, dystrophies, myatonia, myopathies, the development of the long bones and their muscles, and the mechanical theories of the development of congenital malformations are considered. In discussing contractures of nervous origin, the traumatic, neoplastic, and inflammatory lesions of the peripheral nerves are described, together with amputation neuromata and neuralgias, and contractures due to periarticular irritation. The contribution to these contractures by the central nervous system is then explained, as, for example, in the hemiplegias and other spastic lesions, Pott's disease, intradural tumors, vertebral fractures, hematomyelia, syringomyelia, and multiple sclerosis. A large number of cases are due to Little's disease and certain lower motor-neuron lesions of poliomyelitis. Finally, the authors consider contractures due to functional or hysterical causes.

Then follows a review of the general physiopathology of knee contractures based on the mechanics of the joint, the influence of weight, pull on the cruciate ligaments, the capsule, the lateral ligaments, and the ligamenta alaria. In the matter of pure mechanics, due weight is given to the resolution of muscle forces, angles of application, leverage, and the play of agonist and antagonist groups. In the clinical physiopathology, the symptoms of contracture of the individual muscles are considered, as well as the influence of a pathological flexion contracture of the hip upon the knee. The mechanics of weight-bearing upon a contracted knee is fully discussed.

The final section deals with treatment. The optimum position is that of ankylosis of from 10 to 15 degrees. Treatment consists of prophylaxis in infectious cases, correction of subluxation of the tibia by splints, and physiotherapy after the acute stage. In the period of convalescence from poliomyelitis, electrotherapy and heat are advocated. In the spastic cases, muscle training is of the greatest importance. Tuberculous contracture in children yields to continued extension.—*Arthur Steindler, M.D., Iowa City, Iowa.*

USE DESTRUCTION IN THE HUMAN BODY. A. W. Meyer. *California and Western Medicine*, XLVII, 375, 1937.

The author describes in considerable detail the traumatic conditions, resulting from use or motion between two or more surfaces, found in the dissection room. These injuries are of mechanical origin and are classified under thirteen groupings:

1. Superficial and deep synovial bursae. These may be frayed or partially destroyed, without increase of the bursal content.

2. Fraying of articular capsules. The fraying of articular capsules of the knee and of radiocarpal articulations suggests the origin of some of the classic synovial villi.

3. Articular-capsule defects. These defects, large and small, may be present in the shoulder, in the acromioclavicular and hip joints, and in some eleven or twelve other locations.

4. Destruction of ligaments. It is obvious that the glenohumeral, coracohumeral, and femoral round ligaments must be divided during the formation of large defects.

5. Muscle fraying. Muscles sometimes fray when in contact with each other or with other structures.

6. Tendons. Tendons may be frayed on one or both sides. Those most commonly frayed are the tendon of the supraspinatus and that of the long head of the biceps.

7. Dislocation of tendons. Ventral dislocation of the tendon of the long head of the biceps is the most frequent tendon dislocation.

8. Destruction of fibrocartilages. The articular fibrocartilages show fraying, especially the inner margins of the glenoid and genual cartilages.

9. Destruction of hyaline articular cartilages. The hyaline articular cartilages begin disintegrating at the surfaces and this proceeds inward to the bone.

10. Fissuring of the intervertebral discs. The intervertebral discs often are fissured horizontally, seen most often in those spinal areas subject to the greatest motion, and in the latter decades of life.

11. Erosion of bone. When bone erodes through the cortical layer beneath the articular cartilage, the underlying spongiosa becomes sclerosed.

12. Rupture of tendons. Tendons were found ruptured only after attrition and weakening.

13. Formation of bony excrescences. These result from periosteal irritation and may accompany bone denudation.

The author has found no evidence of *restitutio ad integrum*, and he believes that marked destruction can slowly proceed without severe pain or awareness of injury.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

OSTEOMYELITIS OF THE SUPERIOR MAXILLA IN NEW-BORN INFANTS. A. Goldbloom and H. L. Bacal. *The Canadian Medical Association Journal*, XXXVII, 443, 1937.

This condition presents a strikingly uniform clinical picture of fever, swelling of the cheek and eyelids on the affected side, suppuration pointing both on the cheek and inside the mouth, unilateral nasal discharge, augmented by pressure on the cheek, and finally sequestration of one or all surfaces of the maxilla, with loss of deciduous teeth and permanent tooth buds, and often deformity of the affected side of the face. "It is now generally believed that cases reported in the early literature as empyema of the antrum of Highmore in new-born infants were all cases of the condition under discussion." The authors believe that the infection is often staphylococcal.—*D. E. Robertson, M.D., Toronto, Canada.*

TUBERCULOSIS OF THE SYMPHYSIS PUBIS. A. Ambros. *Chirurgja Narzadow Ruchu i Ortopedja Polska*, X, 92, 1937.

The author describes two cases of tuberculosis of the symphysis pubis in young women in whom an arthrodesing procedure would cause a serious set-back in subsequent labor. The author secured good results by sequestrectomy, excision of the foci, packing of resulting cavities with sterilized vaselin, and closure of wounds.—*Emanuel Kaplan, M.D., New York, N. Y.*

POST-TRAUMATIC OSSIFICATION OF THE OBTURATOR EXTERNUS. Z. Ambros. *Chirurgja Narzadow Ruchu i Ortopedja Polska*, X, 99, 1937.

The author reviews the classification of myositis ossificans and cites the rarity of its occurrence in the pubic insertion of the adductors. A case of gradual ossification of the obturator externus in a tennis player is described. The roentgenogram shows a gradual increase in the density of the ossified obturator. The case was observed for three years. The process produced a posterior extra-articular arthrodesis of the hip joint with considerable limitation of motion.—*Emanuel Kaplan, M.D., New York, N. Y.*

ESTADO ACTUAL DEL TRATAMIENTO DE LAS FRACTURAS DEL CUELLO DEL FÉMUR (The Present Status of the Treatment of Fractures of the Neck of the Femur). Ignacio Chavez. *Cirugiay Cirujanos*, V, 453, 1937.

The author has reviewed the diverse and more or less complicated techniques which have been devised for the treatment of the various types of fractures of the neck of the femur. He divides these into three groups: (1) immobilization by mechanical traction; (2) immobilization by plaster-of-Paris casts; and (3) retention of the fragments by surgical means with or without immobilization by mechanical traction or plaster-of-Paris casts.

The first group is represented principally by the method of Phillips which was perfected by Ruth. This method is now practically never used.

The second group comprises the Whitman method with its modification by Apfelbach and Aries, and the Jones technique. The author points out that in elderly patients from 40 to 50 per cent. of the cases treated by the Whitman method result in failure.

He states that the modification of the Whitman method by Apfelbach and Aries is not uniformly successful. He feels that the Jones method has much to recommend it, but he has as yet not been able to obtain definite statistics in regard to end results.

The third group is composed of surgical methods whose object is the maintenance of coaptation of the parts by metal screws; wood, bone, or hornlike supports; metal plates; autogenous bone grafts: the Smith-Petersen nail; and Kirschner wire. The author discusses Albee's operation with its modifications by Ortiz Tirado and Böhler, and Delbet's technique which he considers too complicated for general use. Leadbetter's technique in the reduction of fractures is considered, and the use of the Smith-Petersen nail is described in detail. The author then discusses the technique of Aries and Dyas with the modification by Moore, which is the method that he prefers. He employs the Kirschner wire as the retentive agent.

From his study of these various methods, the author draws the following conclusions:

1. Surgical treatment of fractures of the neck of the femur gives the best results.
2. During the last few years the techniques have been simplified with the tendency to avoid arthrotomy.
3. The easiest technique is that of Dyas and Aries as modified by Moore.—*Carlos Finck, M.D., Torreon, Coah., Mexico.*

DIE AUSHEILUNGSVORGÄNGE AM WIRBELBRUCH UNTER BESONDERER BERÜCKSICHTIGUNG DER FRAGE DER TRAUMATISCHEN SPONDYLOSIS DEFORMANS; (TIERVERSUCHE). [Healing Process in Fractured Vertebrae with Special Consideration to the Question of Traumatic Spondylitis Deformans; (Animal Experimentation).] Alfons Lob. *Deutsche Zeitschrift für Chirurgie*, CCXLVIII, 452, 1937.

In a former article the author proved that there is always a localized spondylitis after isolated injury to the anterior part of the intervertebral disc. In this paper he reports on injuries of the vertebral columns in rabbits. He produced after laparatomy: (1) a fracture to one or two neighboring vertebrae alone; and (2) a fracture to a vertebra plus an injury to the intervertebral disc.

He concludes that the vertebra heals with endosteal and periosteal regeneration, mainly periosteal. The callus is always moderate in amount and is limited to the nearest vicinity of the fracture. There is never any bridging or "*randwulst*". When vertebra and disc are injured, two distinctly different healing processes take place: (1) The repair of the fractured vertebra occurs over osteoid tissue; (2) the repair of the lesion to the disc brings on an enormous proliferation of chondroid tissue which calcifies, forming spondylolytic exfoliations. This proliferation takes place only after injury to the anterior part of the disc, but not when the lateral parts are injured.—*H. D. Bruns, M.D., Iowa City, Iowa.*

KNIEGELENKSARKOM NACH RÖNTGENBESTRAHLUNG (Sarcoma of the Knee Joint After X-Ray Radiation). F. Becker. *Deutsche Zeitschrift für Chirurgie*, CCXLVIII, 11, 1937.

Sarcomata arising as result of the x-ray effect on tissues are very rare clinically. Fifteen cases have been assembled from the literature. The author reports one case in a female, twenty-five years old. At the age of eleven, the patient was treated by x-ray radiation for swelling of the knee, clinically diagnosed as tuberculosis. Tremendous overradiation was administered by a non-medical technician. Six months later, skin atrophy appeared together with a small swelling over the patella. This swelling soon spontaneously subsided. Six years later (1928) the tumor reappeared and grew very rapidly, soon reaching the size of a fist. In 1932 the tumor was resected. Only chronic inflammatory pathology was histologically reported. Clear, small zones of atrophy were visible in the patella and lower femur. In 1935, two months after a pregnancy, the patient returned with marked increase of local findings and an obvious sarcoma of the lower end of

the femur (chondrofibro-osteoid sarcoma on section). Metastases were present in the lung. The patient was still alive at the date of the report.

These sarcomata arise from four to eight years after irradiation. Most of the patients are young people who have been given overdoses of irradiation for tuberculosis. The prognosis is very unfavorable. Most of the cases have revealed histologically a polymorphocellular or spindle-cell sarcoma. Radiation of the epiphyseal zones may be a factor.—*J. E. Milgram, M.D., New York, N. Y.*

CALCINOSIS CUTIS WITH HETEROTOPIC BONE FORMATION. J. G. Finder. *Illinois Medical Journal*, LXXI, 219, 1937.

Little is known of the origin of this disease. Pathologically the process seems to be that of degeneration or damage to tissue, most probably the subcutaneous fat, with resulting calcification. The circulatory rôle is also considered. The changes may be interpreted as follows:

1. Necrotization and impregnation with calcium of the collagenous material.
2. Fibrous-tissue encapsulation.
3. Reorganization.
4. Metaplastic changes, so that formative bone tissue develops and matures.
5. Creeping substitution of the calcified mass and laying down of bony tissue.
6. Continued necrosis of the central elements because of difficulty of organization.

Treatment is based on improvement of circulation and local excision of the masses. One case is reported.—*Donald B. Slocum, M.D., Iowa City, Iowa.*

PATHOLOGIC FRACTURES. Ralph K. Ghormley, Charles G. Sutherland, and George A. Pollock. *Journal of the American Medical Association*, CIX, 2111, 1937.

This paper is based on a study of 600 pathological fractures. These fractures are divided into three groups: (1) fractures due to metastases from malignant lesions; (2) fractures caused by primary malignant lesions of bone; and (3) fractures due to other causes, as benign bone tumors and non-neoplastic bone diseases. No cases involving bone tuberculosis are included in the statistical analyses.

In the metastatic group most of the lesions were of the ribs and vertebrae, with no cases in which the hands or feet were affected. In a large number of cases metastasis to bone followed carcinoma of the breast (127 out of 278 cases), which was also true for hypernephroma, and carcinoma of the stomach, the latter being rarely recognized. Classed as "metastatic malignancy indeterminate", however, were cases in which metastatic bone lesions were found without discoverable primary malignancy. Many of them were believed to have been myelomata.

Osteogenic sarcoma was the most frequent of the primary malignant bone lesions. There were also a relatively large number of fractures associated with Ewing's tumor, which is indicative of the destructive nature of this tumor.

The largest group due to benign bone lesions was composed of cases of senile osteoporosis (ninety-two out of 269 patients). Schmorl has given an accurate description of the pathology. It usually occurs in patients over fifty years of age. It is important in that it is the second most frequent pathological fracture, being surpassed only by that due to metastasis from carcinoma of the breast. The next largest group of fractures resulting from benign bone pathology is comprised of cases of osteitis fibrosa cystica which, for the most part, appears as multiple lesions in shafts of long bones in children. Other causative lesions are giant-cell tumor, osteogenesis imperfecta, and osteomyelitis, in the order of frequency as listed.

Detailed charts accompany the article, which makes the information easily assimilable and should be of aid in making a differential diagnosis of any presenting pathological fracture.—*W. B. Carrell, M.D., Dallas, Texas.*

DIFFERENTIAL DIAGNOSIS OF PAIN LOW IN THE BACK. ALLOCATION OF THE SOURCE OF PAIN BY THE PROCAINE HYDROCHLORIDE METHOD. Arthur Steindler and J. V. Luck. *Journal of the American Medical Association*, CX, 106, Jan. 8, 1938.

The medical literature is incomplete and indefinite in regard to the exact pathology and the manner of occurrence of low-back pain. According to the authors, the old conceptions of lumbosacral and sacro-iliac entities appear inadequate. Many theories of causation have been advanced by investigators, but sufficient proof for acceptance has not been offered. Architectural deficiencies of the lumbar region may be the cause of low-back discomfort and instability. Most congenital anomalies, however, should be considered as predispositional and not as direct etiological factors.

The authors substitute a new vertical for the old horizontal classification of this complaint. They study the routes of the sensory-nerve supply to the tissues of the lumbosacral area. The posterior division of the spinal nerves in this locality supply many important structures, including the sacrospinalis muscles, all of the posterior ligamentous connections, and the intervertebral and sacro-iliac articulations. Irritations from localized peripheral lesions may cause superficial pressure tenderness with radiation of pain along either the posterior or the anterior spinal-nerve divisions. Postural anomalies may be the result. The frequency of radiation of low-spine pain has been estimated as being from 37 to 60 per cent.

Localization of an anterior-division lesion is fairly definite. Intraspinous pathology and extramedullary tumor give accurate indicative signs. Nerve compression within the intervertebral foramen as a cause is being accepted in place of a funicular origin. It is pointed out that many of these symptoms are not due to this form of neural pressure, but have a reflex origin by way of the "nervus sinuvertebralis" described by Purkinje and Luschka.

The posterior-division syndrome comprises the structures supplied by the posterior division of the spinal nerves. These structures act as a unit, and tension is transmitted to them in the forward-flexion test and in the stretching of the hamstrings. These signs are positive in cases of regional fibrositis and myofascitis. In the majority of cases of posterior musculo-aponeurotic or ligamentous involvement, a localized pressure tenderness is present in the sacral triangle.

The anatomical foundations of many of the tests for low-back pain are reviewed and evaluated. The authors reach the conclusion that the symptoms of local tenderness, pain radiation, and faulty posture may apply to the posterior-division as well as to the anterior-division syndrome.

Believing that in many such cases the pain radiation was reflex in nature and not due to root or cord pathology, the authors devised a test in which from five to ten cubic centimeters of 1-per cent. procaine hydrochloride is injected into the localized area of tenderness. The skin is anaesthetized, and the needle is carried down to identify the painful structures. These are then injected with the solution. Five requirements must be met for a positive result. They are:

1. Contact with the needle must aggravate the local pain.
2. Contact with the needle must elicit or aggravate radiation.
3. Procaine-hydrochloride infiltration must suppress local tenderness.
4. Procaine-hydrochloride infiltration must suppress radiation.
5. The positive leg signs must disappear.

Of the 145 patients selected and subjected to the test, 100 (69 per cent.) gave a positive response. Of the original group, conservative treatment was adequate in 103, showing the close agreement between the test and the anticipated results following treatment. Eleven other cases, surgically treated, are presented in detail.

The authors conclude that the posterior syndrome, with its localized tenderness and reflexly radiated pain, occurs in a large number of patients with low-back complaints; and the novocain injection is an accurate test for the presence of this condition.—*Monroe J. Neufeld, M.D., Dallas, Texas.*

INJURIES OF THE KNEE JOINT. Frank D. Dickson. *Journal of the American Medical Association*, CX, 122, Jan. 8, 1938.

Derangements of the knee joint due to trauma are common. The author discusses in detail injuries to the menisci, to the internal lateral ligament, and to the cruciate ligaments.

He points out the fact that the medial meniscus is attached in its posterior half to the internal lateral ligament and that its anterior half is relatively free. Any stress upon the ligament produces a cross-strain upon the cartilage at the junction of the mobile and the immobile portions. In 214 cases of cartilage derangement he found the medial meniscus involved 3.7 times more frequently than the lateral.

The immediate cause is trauma, usually indirect. When the foot is fixed and the knee is partially flexed, inward rotation of the femur puts a direct strain upon the internal lateral ligament. The cartilage is pulled inward and is torn loose at its anterior attachment. It may be fractured or crushed between the grinding articular surfaces. The fracture usually occurs in the middle third.

Diagnosis is based upon a history of a torsion strain upon a flexed knee followed by acute synovitis, an inability to extend the knee completely, and pressure tenderness over the anterior portion of the injured cartilage. In chronic cases the symptoms vary, but, as long as the cartilage remains displaced, limitation of complete extension will persist.

Treatment depends on whether the patient has an initial or a recurring attack. In the former, complete immobilization is desired. A plaster knee cage is worn for three weeks and then weight is borne gradually with the joint protected by an elastic bandage. In recurrent cases, surgery is indicated as the cartilage is apt to be fractured.

The entire cartilage is removed if possible, although the author feels that complete removal is not absolutely necessary in every case.

Injury to the internal lateral ligament is five times more frequent than is damage to the external lateral ligament. Pressure tenderness is usually present over the femoral attachment and the knee is kept partially flexed, less stretch being put on the ligament in this position. Absolute immobilization of the joint in plaster for from four to five weeks is usually sufficient to allow the ligament to heal and to prevent, or at least to minimize, traumatic exostosis or ossification of the ligament at the site of the rupture or tear. If laxity of the joint persists, the ligament may be tightened by moving its tibial attachment downward or, preferably, by reinforcing the ligament with fascial strips.

Rupture of the cruciate ligaments, with or without fracture of the tibial spine, is caused by severe violence. The most constant sign of tibial-spine fracture is a definite bone block to full extension. As a rule, rupture of the cruciate ligaments is not difficult to diagnose. For acute injury, immobilization in plaster for from two to three months is essential. In chronic cases, surgical reconstruction of the ligaments, using fascia lata, is indicated. The results are fairly satisfactory.—*Harold M. Childress, M.D., Dallas, Texas.*

PATHOLOGIC CONDITIONS OF THE SPINE. PAINFUL DISTURBANCES OF THE INTERVERTEBRAL FORAMINA. Lee A. Hadley. *Journal of the American Medical Association*, CX, 275, Jan. 22, 1938.

The author recognizes two distinct types of pathological changes which produce thinning of intervertebral discs and constriction of the intervertebral foramina. The first, occurring in early life, is a herniation of the nucleus pulposus. The second, occurring in later life, is a fragmentation of the cartilaginous plate.

This thinning of the disc brings the vertebral bodies closer together. In the cervical and lower lumbar areas, the posterior articulations are likely to override, producing the so-called apophyseal subluxation. Because of the inclination of the plane of these articulations, subluxation may result in wedging of the lower vertebra forward beneath the one above, producing distortion and constriction of the intervertebral foramen.

In the case of a marked lordosis, some of the patient's weight may be thrust backward

onto the posterior articulations, with the production of extreme apophyseal subluxation even without thinning of the disc, while, as a result of sprain or thinning of the anterior portion of the disc, a reverse subluxation of the apophyseal joints may be visualized as a pulling apart of the articular processes.

A third cause of constriction of a foramen, particularly in the mid-cervical region, is the presence of bony exostoses projecting from the vertebral disc into the lumen.

In addition to the characteristic roentgenographic appearance, patients have pain and tenderness to deep pressure in the neck or back with restricted motion and muscle spasm. Muscle spasm tends to maintain overriding, causing a persistence of pain. Referred symptoms are those of radiculitis with the pain corresponding in distribution to that of the involved nerve root. The patient does not complain of pain on pressure along the course of the nerve, but the nerve roots are painful to deep pressure along the spine. Homolateral or contralateral scoliosis may be present.—*Brandon Carrell, M.D., Dallas, Texas.*

ARTHRODESIS OF THE OSTEO-ARTHRITIC HIP. R. Watson Jones. *Journal of the American Medical Association*, CX, 278, Jan. 22, 1938.

The factors causing incapacity during late osteo-arthritis of the hip joint are pain on movement and weight-bearing, and stiffness of the affected joint. Since pain is the dominating complaint, its relief should be given primary consideration.

An arthroplasty may be relied upon to increase the range of motion, but it does not ensure a painless joint. The author believes that in unilateral osteo-arthritis of the hip joint arthrodesis should be the treatment of choice. This procedure has fallen into relative disfavor since bone fusion has taken place only in about 50 per cent. of the cases, and many are convinced that such a fusion produces or aggravates low-back pain. However, the fact is pointed out that arthrodesis causes a minimum incapacity and even relieves previously existing back pain.

A plaster spica is inadequate for complete fixation, but the rotatory movements may be completely checked by a three-flange nail driven from the femur into the bony pelvis. The nail is started below the greater trochanter and is directed through the femoral neck and head into the roof of the acetabulum. A plaster spica is applied, and the patient is kept recumbent for about three months. The entire procedure is now performed in two stages, an intra-articular fusion is done, followed from ten to fourteen days later by nailing and the application of a plaster spica.

Excellent results are reported in thirty-five cases. The back pain and muscle spasm, as a rule, disappear and from 30 to 40 degrees of pelvic motion develops, which is adequate for ordinary activities.

In thirteen cases in which the ages of the patients ranged from sixty to seventy-five, the author has done a subcutaneous nailing without the preliminary intra-articular fusion. A heavier nail is used, and the patient is up and walking in two weeks. Final end results in these cases have not been determined.—*Harold M. Childress, M.D., Dallas, Texas.*

VERTEBRAL CHORDOMA. S. Y. Minkin. *Khirurgiya*, I, 104, 1937.

A detailed review of the literature is presented, and a case of a vertebral chordoma arising from the transverse process of the eighth and ninth thoracic vertebrae is described. The diagnosis was established after surgical removal of the tumor. The treatment recommended in view of its malignant character is surgical in operable cases. The author's patient survived four years.—*Emanuel Kaplan, M.D., New York, N. Y.*

RESTORATION OF MOBILITY OF THE ELBOW JOINT AFTER THE METHOD OF MOUCHET. S. A. Flerov. *Khirurgiya*, III, 92, 1937.

The author believes that in the operative restoration of motion of the elbow joint

it is not important to interpose any fascia or soft tissue between the newly created joint surfaces; it is also not important to imitate the normal joint configuration.

The essential steps consist in resecting horizontally the joint surfaces, leaving a distance of about four to four and five-tenths centimeters between them. The lateral stability remains good in patients with normal muscles around the elbow joint. Of twelve patients operated upon by this method, the results were excellent in eight; two could not be traced; and two complained of pain and restriction of motion.—*Emanuel Kaplan, M.D., New York, N. Y.*

ON SUTURE TECHNIQUE OF FRACTURES OF THE OLECRANON. A NEW METHOD OF OPERATIVE TREATMENT. G. Y. Epstein. *Khirurgiya*, III, 103, 1937.

Several methods of suturing the fractured olecranon are described. The author gives a description of his own procedure, which essentially consists in passing the tendon of the palmaris longus through transverse drill holes in the fractured fragment and in the ulna. Several cases are reported with satisfactory results. The author also used this tendon for suture in a case of fracture of the patella.—*Emanuel Kaplan, M.D., New York, N. Y.*

BEHANDLUNG UND SPÄTRESULTATE BEI SCHWEREN BRÜCHEN DES HUMERUSGELENKFORTSATZES ERWACHSENER (The Treatment and End Results of Severe Condylar Fractures of the Humerus in Adults). Kurt Johannssen. *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, XLIV, 65, 1937.

The author reviews a series of twenty-two cases, of which fifteen were treated by conservative methods and the remainder by operation. He found that this fracture did not necessarily occur in the aged, nor was the left arm more affected than the right. In eleven of these patients good functional results were obtained, although there remained about 20 to 30 degrees of flexion and extension limitation and a very slight rotation limitation. Eleven other patients could not carry on their previous occupations, due to pain, in spite of the fact that there was no limitation of motion. There were poor results in three cases because of infection, or periosteal callus formation, or radial palsy. Pseudarthrosis and delayed union also played a part.

The author states that each case presents its individual complications and problems and so no set rule can be followed in the treatment. The object is to restore good anatomical position, and, where this cannot be done by manipulation, surgery is indicated. Good anatomical reposition does not necessarily mean good function.

This author claims that conservative treatment is far more advantageous than surgery. He treats most of the cases by means of splints, extension apparatus, wires through the condyles, and casts.—*L. A. Shure, M.D., Iowa City, Iowa.*

ÜBER DORNFORTSATZABRISSE (Fractures of the Spinous Processes of the Cervical Vertebrae). René Sommer. *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, XLIV, 84, 1937.

A review of three cases of fracture of the spinous processes of the cervical vertebrae gave the following information:

Case 1. Injury obtained through shoveling coal resulted in a simple fracture of the spinous process. The fragment was removed without any difficulty. Following the operation the patient would not return to work for many months because of a neurosis which followed his belief that the injury and operation were of a serious nature.

Case 2. The patient had radiating symptoms down the arms and legs. The fragment was removed and soon after this the patient developed more or less paralysis which was not due to but must have accompanied the original injury. However, he thought it was the result of the operation.

Case 3. In this case the patient had sustained fractures of the spinous processes of the fifth and sixth cervical vertebrae, associated with unconsciousness. This was treated

conservatively for three weeks and then the patient was allowed to be ambulatory. Eight months later the patient returned and presented typical cervical deformity. Roentgenograms disclosed that this was due to a compression fracture of the seventh cervical vertebra and a forward dislocation of the sixth cervical vertebra. These had been overlooked originally.

The author concludes that conservative treatment is more desirable. He also warns against missing any associated and more severe damage.—*L. A. Shure, M.D., Iowa City, Iowa.*

THE TREATMENT OF SEPTIC COMPOUND FRACTURES OF THE TIBIA WITH MAGGOTS. Stephen Maddock and Dorothy Jensen. *The New England Journal of Medicine*, CCXVII, 123, 1937.

During the past seven years the authors have treated forty-four cases of compound fracture of the tibia with infection of various degrees. Most of these were true compound fractures, but ten were compounded at operation. A number of compound fractures of other bones were treated, but, as tibial fractures predominated and gave neither the best nor the worst results, they were chosen for the report.

The technique used was that of débridement and application of maggots. The average hospitalization period was seventy days, the average number of days during which maggots were applied was 113, and the average time of healing was 269 days. Of the forty-four patients treated, thirty-two have healed lesions, four are under treatment, one was lost track of, two died of septicaemia, and amputations were performed in five.

The author is of the opinion that the maggot treatment offers the following advantages:

1. Rapid and complete débridement.
2. Discovery of hidden sequestra.
3. Opening of small pus pockets.
4. Stimulation of healthy granulation tissue.
5. Shortening of hospitalization.
6. Early rehabilitation.

The disadvantages of the treatment are:

1. Expense.
2. Discomfort to the patient.

*C. W. Ruhlin, M.D., Iowa City, Iowa.*

HYPERTROPHIC ARTHRITIS OF THE SPINE. John G. Kuhns. *The New England Journal of Medicine*, CCXVII, 317, 1937.

This discussion of hypertrophic arthritis of the spine gives the clinical course and the roentgenographic findings, with many theories as to cause and treatment. The causes suggested are trauma, glandular dysfunction, infection, and toxaemia. Radiating pain due to gradual closure of the neural foramina, which may lead to an error in diagnosis, is also discussed.

The treatment recommended is complete rest in a plaster shell or upon a firm bed, and physiotherapy. Manipulation is discouraged, as it produces an increase in symptoms. Diet and glandular therapy are also considered, but the author feels that they are of doubtful value.—*C. W. Ruhlin, M.D., Iowa City, Iowa.*

SUPRACLAVICULAR BRACHIAL PLEXUS BLOCKS: AN ACCESSORY THERAPEUTIC MEASURE IN ARTHRITIS OF THE SHOULDER JOINT AND ALLIED CONDITIONS. James M. Tarsy and Otto Steinbrocker. *New York State Journal of Medicine*, XXXVII, 1275, 1937.

The authors have utilized the supraclavicular brachial-plexus block as an accessory therapeutic measure in arthritis and allied conditions of the shoulder joint. The patients

TABLE IV

STAPHYLOCOCCUS TITERS IN SURGICAL CASES OTHER THAN THOSE OF PYOGENIC INFECTION

| Affection | No. of Cases | Average Titer |
|---|---|---|
| Acute appendicitis | 36 | 0.6 |
| Vermicular colic | 15 | 1.0 |
| Suspect appendicitis | 3 | 0.46 |
| Ruptured appendix | 1 | 0.3 |
| Head injury | 17 | 0.7 |
| Tuberculosis: | | |
| Spine | 3 | 0.26 |
| Glands | 4 | 0.42 |
| Hip | 8 | 0.78 |
| Hernia | 8 | 0.59 |
| Old poliomyelitis | 16 | 0.78 |
| Burns | 10 | 0.94 |

were studied. (See Tables II and III.) These tables show that there is no great variation in the titer during any particular year or term, and the titers average something under one normal unit. In the ordinary surgical cases seen in the Hospital, other than those of pyogenic infection, the titers were followed. Table IV shows that in these cases there was practically no disturbance of the average titer, except that perhaps in tuberculosis it was lower. In skin infections the titer is usually low; the toxin does not seem to act as an efficient antigen. A study of thirty-seven cases of skin eruptions showed titers varying from 0.1 to 6.0, the average titer being 1.36.

If toxoid is administered to a normal individual, it will be found that his titer is raised. Toxoid is in reality an altered toxin. The addition of formalin to the latter destroys the toxic element, but preserves the antigenic factor. The toxoid which we have used has been furnished by the Connaught Laboratories of the University of Toronto. The titer in a group of nine adults (Table V) was raised as much as sixteen times

TABLE V

STAPHYLOCOCCUS TITERS OF ADULTS WHO RECEIVED SEVEN TO NINE DOSES OF TOXOID

| Case | Before Toxoid | After Toxoid | Approximate Increase |
|---|---|---|---|
| G. M. R. | 0.09 | 1.5 | ×16 |
| E. J. B. | 0.6 | 3.3 | × 5 |
| R. S. S. | 0.6 | 3.7 | × 6 |
| E. M. M. | 0.6 | 3.5 | × 6 |
| J. L. F. | 0.6 | 6.5 | ×10 |
| A. F. | 0.75 | 10 0 | ×13 |
| W. R. S. | 0.8 | 7.5 | × 9 |
| A. J. B. | 1.0 | 14.0 | ×14 |
| A. S. B. | 1.3 | 9.2 | × 7 |

duction of the arm, with traction, is the best. He advises against too much effort, if reduction cannot be accomplished readily.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

LESIONS OF THE CRUCIATE LIGAMENTS OF THE KNEE. RESULT OF THE RECONSTRUCTION OF THE ANTERIOR CRUCIATE AND OF THE TIBIAL COLLATERAL LIGAMENTS. G. Scoppetta. *Ortopedia e Traumatologia dell'Apparato Motore,* May-June, 1937.

In this article the author discusses the question as to whether the two cruciate ligaments are ever in a state of equal tension. From experimental studies he thinks that they are not, which perhaps explains why lesions of the anterior cruciate ligament are so much more frequent. This ligament gets into action first, and the posterior cruciate ligament has more support from the posterior capsule. Stretching of the cruciate ligament without rupture is mentioned as a cause of disturbed ligamentous function. Reaccumulation of bloody fluid in the joint after tapping points to rupture; fat drops suggest avulsion of the tibial spine. The author reports the results which he obtained in two cases of repair of the cruciate ligaments.—*A. W. Ciani, M.D., Iowa City, Iowa.*

RECONSTRUCTION OF THE ACETABULAR ROOF (SHELVING) AS JUDGED BY A STUDY OF FOURTEEN CASES. Luigi Bocchi. *Ortopedia e Traumatologia dell'Apparato Motore,* May-June, 1937.

The author regards this "shelving" operation as logical, generally applicable, and simple, yielding satisfactory results if one is satisfied to use it as an aid, not as a cure, for it is rare that a complete functional or anatomical cure follows its use. Functional reeducation is an important accompaniment. The best results are obtained in the youngest patients. In patients over twenty years of age other methods are superior. Pain is the symptom most often relieved; the limp is only in part obviated. It is important not to place the shelf too low, in which case it is more readily absorbed.—*A. W. Ciani, M.D., Iowa City, Iowa.*

L'ANTIPYRINE DANS LE TRAITEMENT DU RHUMATISME ARTICULAIRE AIGU (Antipyrine in Treatment of Acute Articular Rheumatism). L. Bouchut et M. Levrat. *La Presse Médicale,* XLV, 1467, 1937.

Following the discovery of antipyrine, this drug was used extensively in the treatment of acute rheumatic fever. With the introduction of the salicylates, antipyrine has fallen into an unjustifiable disuse. The authors claim that the accidents attributed to the use of antipyrine are due, not to intoxication, but to intolerance. In their experience, harmful effects have not been observed. Indeed, they note that where albuminuria is caused by a rheumatic affection of the kidneys, the albuminuria is definitely benefited. Next to the salicylates, antipyrine is considered specific, as well as antipyretic and analgesic, in its effect upon the rheumatic process. In cases where the condition is resistant to the action of the salicylates, or where intolerance limits the use of the salicylates, antipyrine may be given confidently. Doses as large as six to eight grams have been given daily for several days and the action has been continued with daily doses of four grams for longer periods of time. The drug is given by mouth in capsules or in solution. Because of certain irregularities in the commercial product, the authors recommend special preparations of the drug.—*Henry Milch, M.D., New York, N. Y.*

INDICATIONS OPÉRATOIRES ET TECHNIQUE DE L'INTERVENTION DANS LES FRACTURES DES APOPHYSES TRANSVERSES LOMBAIRES (Operative Indications and Technique in Fractures of the Transverse Lumbar Processes). R. Dupont et H. Evrad *La Presse Médicale,* XLV, 1573, 1937.

used as controls were good risks and free from procaine sensitivity, in whom the common therapeutic measures had failed to give relief. Twenty-one patients with arthritis, bursitis, and brachial-plexus neuralgia were treated. The anatomical relations were carefully taken into consideration, and the point of injection was lateral to the subclavian artery, posterior to the clavicle, and anterior to the first rib. From five to ten cubic centimeters of 1-per-cent. procaine was injected in each case. Seventeen of the twenty-one patients showed moderate to excellent recovery of function.

The return of function is interestingly accounted for on the basis that muscle spasm, previously caused by a reflex action, has been released. The lasting effect of the procaine is explained rather conclusively as producing a block, thereby prolonging the sensory cycle long beyond the effect of the anaesthetic. It is also thought that the pain threshold has been elevated and that the previous stimulus no longer produces pain and, therefore, allows freedom of motion.—*C. W. Ruhlin, M.D., Iowa City, Iowa.*

Simple Apparatus for Re-education of Paralysed Muscles. Campbell McKenzie. *New Zealand Medical Journal*, No. 196, 380, 1937.

The author describes an apparatus for developing voluntary motion in paralyzed limbs, which was devised by Mr. V. Pike, the masseur at Timaru Hospital. The apparatus consists of a piece of aluminum, one-eighth of an inch in thickness, in the shape of a protractor. It has a movable arm pivoted around a thrust bearing, which swings on a ball-bearing roller. A track of monel metal is screwed to the aluminum to prevent the roller from cutting into it. Inside the arm is a sliding extension piece to which is attached a foot support.

The use of this apparatus is advocated for the following reasons:

1. It is simple and compact, and, as it does away with the effect of gravity, it is better than the bath.
2. It almost entirely abolishes friction.
3. The limb is under better control than it is with the bath, slings, or a plane surface.
4. Exercise can be graded, resistance added, and amplitude measured with great ease.
5. It catches and holds the patient's attention.—*H. Walden Fitzgerald, F.R.A.C.S., Dunedin, New Zealand.*

Auckland Clinical Society Reports. *New Zealand Medical Journal*, No. 197, 43, Feb. 1938.

The case described by Mr. Morris Axford was that of a simple transverse fracture of the patella, which had been treated by complete excision of the bone and repair of the quadriceps muscle with fascial strips. The patient, a man of sixty-seven years, five weeks after the accident walked without any perceptible limp, with a powerful extension of the knee, no wasting of the quadriceps, and 60 degrees of active flexion of the knee. He was able to do light work.—*H. Walden Fitzgerald, F.R.A.C.S., Dunedin, New Zealand.*

Fracture of Neck of Scapula. Max R. Charlton. *Northwest Medicine*, XXXVII, 18, Jan. 1938.

The author refers to the scarcity of reported cases of fracture of the neck of the scapula and presents a bilateral case of his own. The fractures in this case were caused by a falling tree which struck the patient across the back. Usually the fragment is displaced downward and inward; this occurred in this case on the right side, but the left side was not displaced.

Diagnosis is made by abduction of the arm and inward pressure on the shoulder, causing pain, and by the presence of marked swelling over the entire scapula.

A variety of methods for reduction are described, but the author believes that ab-

Two cases of benign and one case of malignant giant-cell tumor involving the spine are reported in detail. Treatment by radiation was effective in causing regression, but marked bone absorption and apparent extension frequently occur shortly after institution of radiation therapy, to be followed later by bone regeneration.

Since tumors having all the clinical and roentgenological characteristics of benign giant-cell tumor occasionally are malignant, the authors feel that aspiration biopsy is advisable in other locations than the spine. There it is of much less value, since conservative treatment must be used regardless of the type of tumor.

Curettage, followed by a cauterization of the cavity with an escorotic, is followed by recurrence in from 14 to 20 per cent. of the cases.

Treatment by radiation, although slow in effect and frequently producing a stage of lysis and apparent extension before bone regeneration begins, is gaining ground.—*Edward N. Reed, M.D., Santa Monica, California.*

PENETRATING WOUNDS OF THE KNEE. I. THE PRODUCTION OF EXPERIMENTAL ARTHRITIS. II. THE ESCAPE OF PARTICULATE AND FLUID MATERIAL FROM THE NORMAL KNEE JOINT. A. Lewer Allen. *The South African Journal of Medical Sciences, I, 31, 1935.*

Penetrating wounds of the knee caused by sharp splinters of rock are injuries frequently encountered among the workers in gold mines on the Witwatersrand. In some of these injuries an acute arthritis occurs, the organism being almost invariably a hemolytic streptococcus.

Experimental reproduction of these conditions was attempted by injecting organisms into the knee joints of cats. An acute arthritis was produced. The organisms escaped from the joints at an early stage and were sometimes found in the lymph nodes draining the joints. Particulate matter (India-ink particles and blood corpuscles) and non-particulate solutions (1-per-cent. trypan blue) leave the joint of the cat by way of the lymphatics and reach the iliac glands. Movement of the joint acts as a pump ("lymph-heart" action), being mainly responsible for the escape of fluid by way of the lymphatics.—*Clark W. Heath, M.D., Boston, Massachusetts.*

HERNIATION OR RUPTURE OF THE INTERVERTEBRAL DISC. A REPORT OF TWO CASES. R. F. Slaughter. *Southern Medical Journal, XXX, 803, 1937.*

The author presents two cases which were proved at operation, and the patients were completely relieved of disability that had been designated as permanent. Trauma was present in both cases. The patients complained of low backache with sciatica-like pain. There was increased protein in the spinal fluid, but no block. Roentgenographic studies after injection of iodized oil in one case showed a filling defect.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR WITH THE SMITH-PETERSEN NAIL. James W. Davis. *Southern Medicine and Surgery, C, 45, Feb. 1938.*

Fractures of the intracapsular neck of the femur constitute one of the most distressing problems of today, but this problem is most accurately handled by the subcutaneous fixation of the fracture, after reduction, with a Smith-Petersen nail. The author uses fluoroscopic guidance in inserting a guide wire or pin and then drives the nail on over the pin. He has also used the Austin Moore metal bone pins with good results.

The author believes that in his cases the mortality and morbidity rates have considerably decreased since he has used this method of fixation of femoral-neck fractures.—*Herbert E. Hipps, M.D., Marlin, Texas.*

The disability resulting from fractures of the transverse processes of the lumbar vertebrae, treated conservatively, varies from an estimate of 85 per cent. to 10 per cent. The results of the operative treatment "are always excellent". Operative intervention is not recommended until after conservative treatment by means of a plaster jacket has been tried for at least two or three months. If, at the end of that time, symptoms still persist, operation is advised.

With the patient in the ventral position, the operative approach is made through a long, curved, skin incision, so placed as to be external to the aponeurotic incision. This is made directly over the prominence of the erector spinae muscles, between the spinous processes and the lateral groove which marks approximately the tips of the transverse processes. The muscle fibers are separated, and the transverse process is removed subperiosteally. The base of the transverse process is removed by rongeur. The wound is closed by interrupted muscle stitches. At the end of about two weeks, gradual resumption of function is permitted.—*Henry Milch, M.D., New York, N. Y.*

BLOOD VESSEL MARKINGS IN THE DORSAL VERTEBRAE SIMULATING FRACTURE. Kenneth S. Davis. *Radiology*, XXIX, 695, 1937.

Transverse slits in the bodies of thoracic vertebrae were observed in about 10 per cent. of all lateral roentgenograms of the thoracic spine, in persons from twenty to seventy-six years of age. These slits apparently divide the bodies into symmetrical halves.

Lateral roentgenograms of spines removed from cadavera showed these transverse markings in approximately 22 per cent. Injection of the blood vessels of the removed vertebrae with a barium suspension and x-raying them, followed by sectioning in transverse, anteroposterior, and longitudinal planes, showed the transverse linear marks to be due to blood-vessel channels in practically all cases. The vessels come from the anterior spinal arteries, but always enter the vertebral bodies in the center of the posterior body wall, just above the exit of the basivertebral veins.

The "translucent split" seen in the anterior portion of the bodies of vertebrae in children is probably due to a middle zone of ossification of less density than the zones between which it lies. This slit extends from before backward, and does not persist in adults.

Recognition of these anomalies is important in cases involving the question of trauma to the spine, with possibility of fracture.—*Edward N. Reed, M.D., Santa Monica, California.*

GIANT-CELL TUMORS OF THE SPINE. G. E. Richards and A. C. Singleton. *Radiology*, XXX, 43, Jan. 1938.

Benign giant-cell tumor occurs about half as frequently as primary malignant bone tumors. The usual age incidence is from fifteen to forty years. The most common sites are the upper tibia, the lower femur, the lower radius, the epiphyses of other long bones, the jaw, and the spine. This tumor practically always involves the epiphysis, and it is central in origin, expansive in type, and often asymmetrical. Cortical destruction and periosteal expansion with subperiosteal new bone formation produce a "blown-out" appearance. There is a sharp demarcation between tumor and normal bone. Coarse bony trabeculation gives it a characteristic loculated appearance. Another group, less numerous, are frankly osteolytic, with no attempt at bone repair, no trabeculation, and without sharp demarcation between tumor and normal bone, the cortex usually being completely absorbed. Tumors of this type are difficult to differentiate from primary malignant new growths or from metastases. Giant-cell tumors usually do not cross cartilage. Pathological fracture is common. The disease is relatively uncommon in the vertebrae. While any part of a vertebra may be involved, there is a predilection for pedicles and transverse processes. The diagnosis is difficult because of the multiplicity of bone lesions which affect the spine.

DIE BIFURKATION MIT HILFE DES TROCHANTER MINOR (The Bifurcation Operation with the Help of the Lesser Trochanter). Julius Hass. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 353, 1937.

In neglected cases of dislocation of the hip in which the lesser trochanter lies opposite the acetabulum, this trochanter forms an excellent weight-bearing point in subtrochanteric osteotomy. Hass recommends adduction of the proximal fragment with the end of the diaphysis under it instead of in the acetabulum as in the classic bifurcation operation. With this change, he obtains better motion and prolonged weight-bearing with less pain.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ZWEI FÄLLE VON OS NAVICULARE PEDIS BIPARTUM (Two Cases of Os Naviculare Pedis Bipartitum). Cornelius Volk. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 396, 1937.

The author reports two cases of bipartite navicular. Each case was unilateral and in an adult in the third decade of life. Each patient complained of foot pain. One was treated, and relieved with an insole. Ossification of the navicular begins at the age of from three to five, and, in part of the cases reported, originates in two centers of ossification.

The shape of the astragalus in these two cases was somewhat unusual, the head of the bone having a changed contour to articulate with the abnormal navicular.—*J. E. Milgram, M.D., New York, N. Y.*

ZUR BEHANDLUNG DES PLATTFUSSES NACH DER OPERATIONSMETHODE VON PROF. DR. PETŘIVALSKÝ (The Treatment of Flat-Foot by the Petřivalský Operation). Čestomir Vohnout. *Zentralblatt für Chirurgie*, LXIV, 310, 1937.

Moderately severe cases of flat-foot which do not improve under conservative measures are treated by an operation which raises the inner longitudinal arch and corrects the pronation of the hindfoot. This is accomplished by making a long rectangular periosteal flap on the medial aspect of the lower portion of the tibia. The flap remains attached just above the internal malleolus. The periosteal flap is turned down and fastened to the scaphoid and cuneiform bones and along the internal ligaments of the foot.

This operation has been performed by the author seven times with good results in all but one case. Petřivalský has been performing this operation since 1930. A similar operation was described by Löffler in 1931.—*Harold Unger, M.D., Iowa City, Iowa.*

ÜBERBRÜCKUNGPLASTIK BEIM MUSKULÄREN SCHIEFHALS BEHUFS HERSTELLUNG EINES NORMALEN HALSRELIEFES (Bridge Plastic Operation in Muscular Wry Neck to Restore Normal Neck Contour). C. Springer. *Zentralblatt für Chirurgie*, LXIV, 1634, 1937.

In place of subcutaneous or open tenotomy, the author advocates division of the contracted muscle with bridging of the gap so created in the sternocleidomastoid. To bridge the gap, he utilizes a strip of fascia lata. By this means, the contour of the neck is better maintained. The method is applicable to secondary operations to restore neck contour. A double-tailed flap might conceivably be employed and attached both to the sternal and to the clavicular stumps. The author advises support of the neck for one year. He believes that this procedure should not be employed in patients under the age of two years.—*J. E. Milgram, M.D., New York, N. Y.*

DIE ENTWICKLUNG DER JUVENILEN KYPHOSE (The Development of Kyphosis Juvenilis). Johannes Schildbach. *Zentralblatt für Chirurgie*, LXIV, 2086, 1937.

The author reports 167 cases from the Orthopaedic Department of the University Hospital. From his study of these cases he has noted the following typical changes:

Die Behandlung der Folgezustände nach Kinderlähmung (The Treatment of the Conditions Following Infantile Paralysis). Julius Hass. *Wiener klinische Wochenschrift*, L, 1670, 1937.

A general discussion of the orthopaedic management of the subacute and chronic stages of poliomyelitis contains numerous statements of interest to orthopaedic surgeons. General measures for the prevention of deformity are of the greatest importance. If this fact has been overlooked, contractures are most gently corrected by the "*Quengel*" method of Mommsen. Muscles are strengthened by baths, massage, electrical stimulation, gymnastics. The patient should be started walking as soon as possible, for walking is the best exercise. Various types of apparatus may be necessary to permit this. There is still hope of improved function two to three years after the acute attack, largely through hypertrophy or substitution of muscles. Operations, including tendon transplantation, arthrodesis, and arthrocreisis, are discussed.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Der angeborene Klumpfuss (Congenital Club-Foot). Georg Hohmann. *Zeitschrift für ärztliche Fortbildung*, XXXIV, 609, 1937.

A brief summary of the treatment of congenital club-foot in rather popular style emphasizes the importance of early gentle correction of the adduction, followed by correction of the supination of the forefoot and later of the hindfoot, and, finally, correction of the equinus. One should guard against producing a flat foot or rocker foot. Various operative measures are mentioned.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Familiäres Vorkommen der Protrusio acetabuli. Beitrag zur Ätiologie. [Familial Incidence of Protrusion of the Acetabulum. Contribution to Etiology.] Gickler. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 14, 1937.

The author observed two cases of Otto's protrusion of the acetabulum in one family. Both patients were adults, and in each case the lesion was of long duration. He believes the lesion is congenital, in that a weak acetabular floor gives way. He also reports two cases in non-related children. In one a slipped epiphysis of the femur was present. On this rather slim evidence he decides that the lesion is familial.—*J. E. Milgram, M.D., New York, N. Y.*

Die Bedeutung des Chopart'schen Gelenkes für die Dorsal- und Plantarflexion bei Versteifungen des oberen Sprunggelenkes (Significance of Chopart's Joint for Dorsiflexion and Plantar Flexion in Ankylosis of the Ankle Joint). Max Zimmermann. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 20, 1937.

Measurement of five cases of ankle-joint ankylosis demonstrated dorsiflexion ranges up to an angle of 90 degrees and plantar-flexion ranges to an angle of 125 degrees.

Despite the common teaching that normally 20 degrees of motion in the plantar and dorsal direction is present in Chopart's joint, the author tested some children and adults by attempted plaster immobilization of the hind foot. He reports that children show from 10 to 15 degrees of such motion and adults but 5 degrees.

The increased ranges in feet which have been operated upon are a compensatory development.—*J. E. Milgram, M.D., New York, N. Y.*

Erbbiologische Untersuchungen über die Anlage zur "angeborenen" Hüftverrenkung (Hereditary Biological Investigation in Congenital Dislocation of the Hip). Alexander Faber. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 140, 1937.

The author repeats the very important dictum that if the hips of families are roentgenographically examined, three cases of dysplasia of the hip will be found for one case of true congenital dislocation. In other words, the lesion is four times as frequent biologically as one might think.—*J. E. Milgram, M.D., New York, N. Y.*

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# The Journal of Bone and Joint Surgery

## THE FIRST STAGES OF COXA PLANA *

BY HENNING WALDENSTRÖM, M.D., STOCKHOLM, SWEDEN

In 1909, Legg and also the author described a hitherto unknown deformity of the hip. In 1910, Calvé and then Perthes described the same thing. Our observations have all proved to be correct except in regard to the etiology of the disease,—each of us expressed a different opinion, but none of us was right. The etiology of the disease is still an unsolved problem. Among the various names that have been given to it, "Perthes' disease" and "osteochondritis deformans" are the most common. The former is badly chosen, however, as Perthes was not the first to describe the disease. The latter is equally unfortunate, as it conveys a wrong idea: the disease is not inflammatory—that is, it is neither an osteitis nor a chondritis. In 1920, therefore, the writer suggested the name "coxa plana", a term which, like "coxa vara", takes no account of the etiology, but only of the appearance of the deformity,—namely, the flattened epiphysis.

By many authors the term "coxa plana" is used as a designation merely for the later stages of the disease, because they believe that only then has the head become flattened. This is not the case, however. The studies which the author has made show that the flattening of the epiphysis is the principal sign of the pathological process in its very earliest stage. From a study of the anatomical specimens, we know that the pathological process is a primary necrosis, followed by resorption of the necrotic cancellous tissue, and, at last, formation of new bone and cartilage.

The studies on which this paper is based comprise cases of coxa plana selected from those which the author has treated personally during the last thirty years. Of these, thirteen came under his observation at so early a stage of the disease that they have enabled him to demonstrate the beginning of the coxa plana.

The first symptom of the disease is limping, sometimes associated with pain in the hip or, more commonly, toward the knee. In the beginning, these symptoms appear only after some strong exertion, and they disappear when the patient has rested a while. When the patient first comes to the doctor in this initial stage, the limping is often so slight that

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

(1) a slightly rounded kyphos between the seventh and tenth thoracic vertebrae with prominence of the ribs; (2) narrowing of the vertebral bodies anteriorly with irregularity of the epiphyses. The roentgenographic examination shows four stages,—namely, irritation, destruction, reparation, and proliferation. The early symptoms, as shown in the roentgenogram, are narrowing of the intervertebral space and disturbances of the epiphysis (*Randleiste*). If the process is progressive, wedge-shaped vertebrae with resulting spondylosis may develop. In some cases bony nodules were observed. The treatment consists of orthopaedic exercises, correction by recumbency on a frame, complete rest in fresh air for several months, and continued observation for several years.—*Ernst Bettmann, M.D., New York, N. Y.*

Die operative Verlängerung des Beines (Operative Lengthening of the Leg). J. Schulz. *Zentralblatt für Chirurgie*, LXIV, 2294, 1937.

This operation involves two procedures,—namely, the section of the bone and the stretching of the tissue. The author describes the old subtrochanteric oblique osteotomy by which lengthening of six centimeters was possible, especially in cases of adduction contracture of the hip. The transperiosteal method has been abandoned because periosteal necrosis and pseudarthrosis have been observed. Osteotomy between the middle and inferior thirds of the femur is recommended because the periosteum remains in contact with the musculature. The author advises gradual extension, beginning with three kilograms and increasing to twenty kilograms. Weight-bearing is not permitted before the fifth month.—*Ernst Bettmann, M.D., New York, N. Y.*

Grundsätzliche Bemerkungen zur Anzeigestellung und zur Behandlung verschleppter bzw. pseudarthrotisch oder nearthrotisch geheilter medialer Schenkelhalsbrüche (Axiomatic Observations on the Symptoms and Treatment of Pseudarthrosis or Non-Union of the Neck of the Femur). Fritz Felsenreich. *Zentralblatt für Chirurgie*, LXIV, 2407, 1937.

The nail treatment of Smith-Petersen, Johansson, and Böhler is compared with the subtrochanteric wedge osteotomy of Pauwels. The first method permits earlier bony consolidation and weight-bearing. The most important part of the treatment is the reduction of the fracture, followed by extension for two weeks or until the neck is in position opposite the head. Bony union is obtained by longitudinal traction in abduction and inward rotation. Before manipulation three roentgenograms should be taken in the following positions: inward rotation, outward rotation, and lateral. Abduction of at least 25 degrees should be maintained. If there is much resorption from the head and neck, osteotomy is preferred, after which the legs are kept in abduction for fourteen weeks and no weight-bearing is allowed.—*Ernst Bettmann, M.D., New York, N. Y.*

TABLE VI

STUDY OF THE ANTIHEMOLYTIC ACTION OF THE BLOOD IN FOUR ILLUSTRATIVE CASES OF STAPHYLOCOCCAL OSTEOMYELITIS

| Case | Age (*Years*) | Date | Antitoxin Titer | Remarks |
|---|---|---|---|---|
| R. W. | 7 | April 25, 1937 | 1.0 | |
| | | April 27, 1937 | 1.0 | Negative blood culture after April 25. |
| | | April 29, 1937 | 1.0 | |
| | | May 3, 1937 | 4.0 | |
| | | May 7, 1937 | 8.0 | |
| | | May 17, 1937 | 10.0 | |
| M. M. | 10 | May 9, 1935 | 3.6 | Negative blood culture. |
| | | May 14, 1935 | 6.0 | |
| | | May 16, 1935 | 6.0 | Metaphyseal abscess drained. |
| | | Toxoid started | | No sequestrum. |
| | | May 22, 1935 | 10.0 | |
| | | July 9, 1935 | 44.0 | |
| H. F. | 10 | September 20, 1935 | 0.3 | |
| | | September 21, 1935 | 0.3 | |
| | | September 23, 1935 | 1.0 | |
| | | September 24, 1935 | 3.0 | |
| | | September 25, 1935 | 5.0 | |
| | | September 26, 1935 | 7.0 | Positive blood culture until September 27. |
| | | September 27, 1935 | 12.0 | |
| | | September 28, 1935 | 13.0 | |
| | | September 30, 1935 | 14.0 | |
| | | October 2, 1935 | 17.0 | |
| | | October 9, 1935 | 13.0 | |
| | | October 21, 1935 | 21.0 | |
| | | November 11, 1935 | | |
| | | Toxoid started | | |
| | | January 5, 1936 | 40.0 | |
| | | September 30, 1936 | 10.5 | |
| E. B. | 10 | May 31, 1935 | 3.6 | |
| | | June 3, 1935 | 3.6 | Negative blood culture. |
| | | June 5, 1935 | 3.3 | Healed without sequestrum. |
| | | June 7, 1935 | 4.4 | |
| | | Toxoid started | | |
| | | June 15, 1935 | 7.2 | |
| | | June 19, 1936 | 12.5 | |
| | | March 9, 1937 | 10.0 | |

in one case, and as much as five times in the individual who reacted the least. The highest titer before inoculation was lower than the lowest level after inoculation. It is, therefore, possible clinically with one course of toxoid to raise a patient's antihemolytic titer at least five-fold.

No experiments with the administration of vaccines—that is, dead staphylococci—have been done to find the effect, if any, upon the titer of a

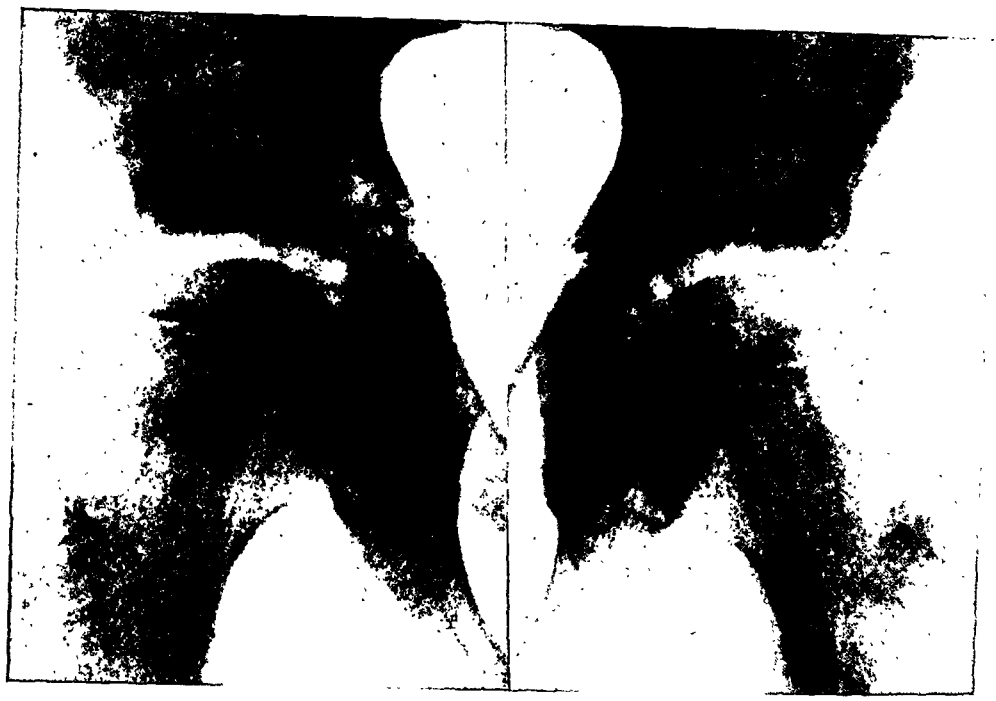


FIG. 1-A



FIG. 1-B



FIG. 1-C

M-n, a boy, aged nine years, was admitted to the hospital on September 6, 1932, with a slight limp of three months' duration.

Fig. 1-A: Roentgenogram, taken on admission, showing the epiphysis of the right femur to be lower than that of the left and flattened on its upper portion, as well as an increase in the distance between the epiphysis and the bottom of the acetabulum.

Fig. 1-B: Lateral view (Lauenstein's position), taken on admission.

Fig. 1-C: Lateral view, taken one year later.

it is not noticeable to the eye; although, when he is made to walk across the floor with his shoes on, it may often be heard. Besides the limp, there was in all the writer's cases a restriction of mobility sufficiently definite to be measured in degrees when compared with the sound hip. In the beginning this restriction of mobility very soon disappears if the patient is kept in bed.




FIG. 1-D

Lateral view (Lauenstein's position), taken five years later, showing the final stage, with slight deformation of the head.

The writer has treated four cases in which the symptom of limping had been present for some weeks only. The roentgenographic appearance at that time was normal, but, as in all four cases the roentgenograms were taken in the anteroposterior direction only (at other hospitals), it may be that the lateral projection (Lauenstein's position*) might have shown some changes. All of the author's early cases prove that in the beginning the deformity is always more pronounced in the lateral view. (See Figures 1-A, 1-B, 2-A, and 2-B.) Soon, however—two or three months after the beginning of the limping—the characteristic signs of coxa plana began to be visible: that is, the normal structure of the cancellous tissue in the upper part of the epiphysis on the articular surface began to be resorbed.

The changes to be observed in the roentgenograms taken at this early stage are very slight, and a minute comparison of the two hip joints is required to discover them. Both sides have to be very carefully and symmetrically exposed on the same film. In order to make it easier for the reader to get a simultaneous view of the two hip joints, the writer has cut away the central part of the films on which the hip joints and the pelvis have been photographed symmetrically, and has placed the two joints side by side, as close to each other as possible (Figs. 1-A through 2-C). It may now be seen that the form of the two sockets is identical. If we compare the femoral epiphyses, we find that the epiphysis on the right side is lower and shows a distinct flattening of the part facing the roof of the acetabulum. In the roentgenograms taken in Lauenstein's flexion-abduction position, this flattening is still more apparent.

It will be noted that the flattening mainly involves the upper anterior part, while the lower portion has retained its normal shape. This is due to the fact that only the upper anterior part is necrotic. If we look more closely, we find at the top—that is, in the upper part of the epiphysis where it looks as if something had been worn away—a thin, hardly distinguishable line concentric with the epiphysis. This narrow strip indi-

* Taken with the femur in flexion and abduction.



FIG. 2-A



FIG. 2-B



FIG. 2-C

R. E., a boy, aged seven years, was admitted to the hospital in January 1936, with a very slight limp of six weeks' duration.

Fig. 2-A: Anteroposterior view on admission.

Fig. 2-B: Lateral view on admission.

Fig. 2-C: Anteroposterior view one year later.

cates the position of the joint cartilage. It is visible in the roentgenogram only because a narrow margin of the bone has not become resorbed, and is, therefore, still in its place close to the cartilage. Underneath this strip there is a bright zone, caused by a subchondral resorption of necrotic bone. The cartilage of the joint has thus lost its natural support and has been pressed together. The necrosis may involve more or less of the epiphysis; sometimes, only the upper anterior part; and, in the most extensive cases, the whole epiphysis with the adjacent part of the neck. The necrosis never involves only the lower part of the epiphysis.

When one examines the roentgenograms of these incipient cases of coxa plana, one notices a constant change in the diseased hip joint, consisting in an increase in the distance between the femoral epiphysis and the bottom of the acetabulum or, to put it more clearly, an increase in the distance from the epiphysis to the lateral leg of the U-shaped figure. In the author's opinion, the explanation of this phenomenon is as follows: In roentgenograms of coxa plana in its first stages, the acetabulum is of normal shape and is like that of the normal hip. The cause must, therefore, be found in the head-neck portion of the femur. The muscles of the hip joint press the head against the roof of the acetabulum. Above, the head finds the firm roof of the socket; the head then moves upward and laterally. It does not fit into the socket, which can be easily seen from this increase in distance between the epiphysis and the bottom of the socket. The empty bottom of the socket is then filled with synovia, as may be seen where per-abrodil has been injected into the joint (Fig. 3-B) after aspiration of an increased volume of synovia. The increase in the distance between the epiphysis and the bottom of the socket may also be observed in another way. In roentgenograms of the hip in the anteroposterior projection, the posterior margin of the acetabulum—which is developed from the ischium—is always seen as a curved line intersecting



FIG. 3-A FIG. 3-B

Fig. 3-A: Coxa plana in the stage of fragmentation.

Fig. 3-B: After injection of per-abrodil (iodine contrast solution) into the capsule, showing that the enlarged space between the epiphysis and the bottom of the socket is filled with synovia and not with any tissue.

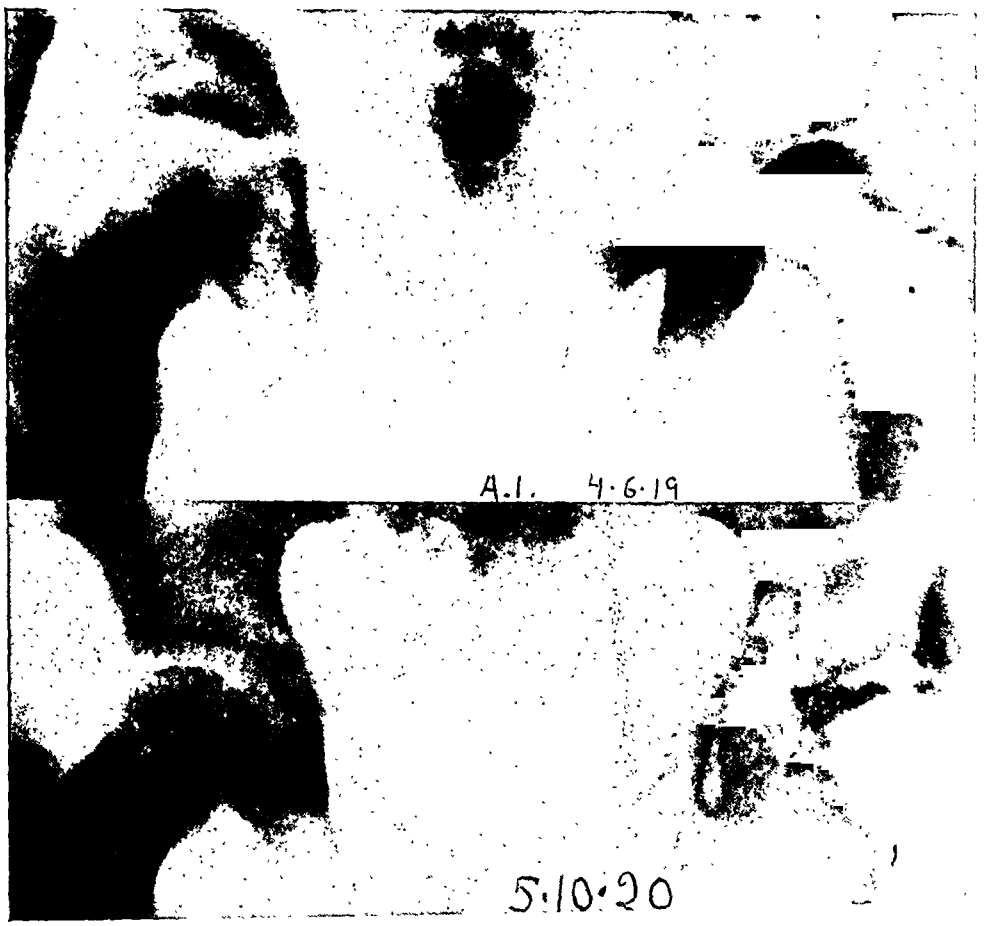



FIG. 4

A-g, a boy, aged eight years.

Fig. 4-A (*upper*): Roentgenogram, taken in June 1919, showing beginning coxa plana in the right hip joint and a normal left hip joint.

Fig. 4-B (*lower*): Roentgenogram, taken in October 1920, showing coxa plana in the stage of fragmentation on the right and a still normal hip on the left, sixteen months after the first roentgenogram had been taken.

the head in its medial part. The contact between the ischium and the head is less in the hip where the coxa plana exists than in the opposite sound hip. (See Figures 1-A, 2-A, and 2-B.)

This change in the position of the epiphysis in relation to the acetabulum was observed by Jansen, who explained it by assuming a congenital variation in the shape of the acetabulum, which he called "a wide hip socket"; according to him, this should be the cause of coxa plana. The roentgenograms which he reproduced in support of his theory, however, were from cases in which the process was too far advanced at the time they were taken to allow any hypothesis in regard to the primary or secondary nature of the changes to be based upon them. On the other hand, the writer's roentgenograms show the earliest stages of coxa plana which have as yet been published, and they permit us to conclude that at the beginning the size and shape of the socket are normal. There is no "wide hip socket" in the initial stage of coxa plana. The condition described by Jansen under that name is the result of the changed position of the

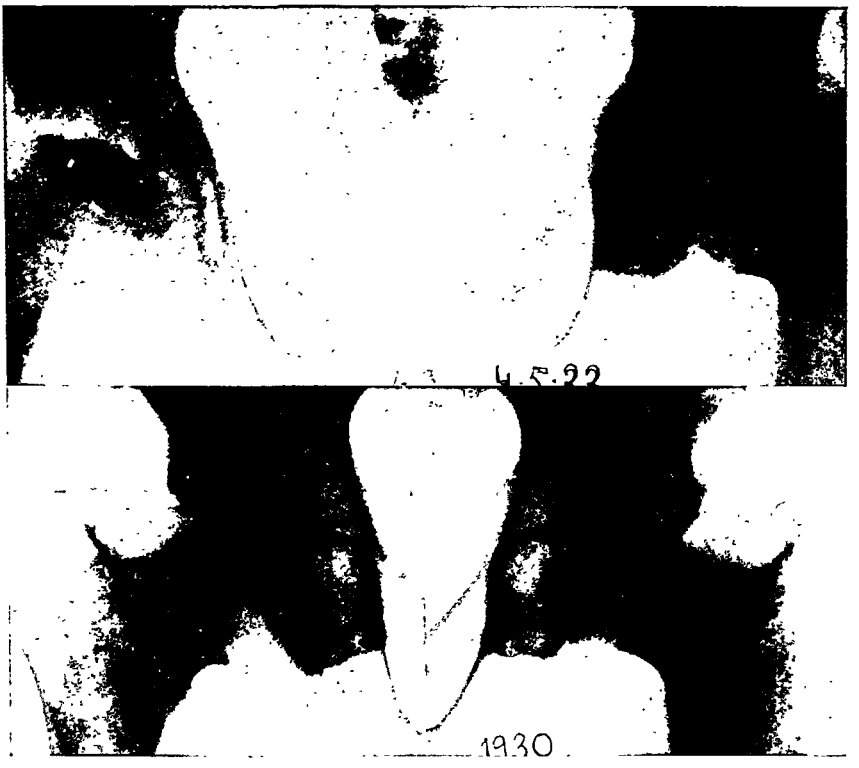



FIG. 4

Fig. 4-C (*upper*): Roentgenogram, taken in May 1922, showing coxa plana of both hip joints.

Fig. 4-D (*lower*): Roentgenogram, taken in 1930, showing the final stage on both sides: on the right, deformation of the highest degree (tap-shaped); on the left, of medium degree (mushroom-shaped or egg-shaped).

epiphysis in relation to the acetabulum; or, to express it as cautiously as possible, it is seen in the roentgenogram that the lower portion of the epiphysis is separated from the bottom of the socket, but the form of the latter remains normal. If one has seen roentgenograms of this terminal stage only, one may easily persuade oneself that the sloping roof is the primary process and the real cause of the deformation of the head. Calot made that erroneous conclusion, and called the coxa plana "*une subluxation congénitale méconnue*". When the head shrinks, it travels upward and outward in the acetabulum—that is, in the same direction as in the case of a subluxation—but these changes have nothing to do with the form of the acetabulum.

In all of the author's cases of coxa plana, the distance between the epiphysis and the bottom of the acetabulum has always been increased no matter how small the changes in the epiphysis. The question now arises: What was the condition before the beginning of the coxa plana? The only possible way of solving this problem, as far as the writer can see, is by means of roentgenograms of the hip taken a long time (not less than

a year) before there are any symptoms from the joint, and by additional roentgenograms showing typical signs of coxa plana. That possibility exists only in cases where the process is bilateral. Therefore, the writer has gone through his material and has picked out the bilateral cases for a careful study. Among them there were three which answered the claims that have been proposed. *The joint of the opposite side was normal in all cases.* In all of these previously normal hip joints, a coxa plana developed a long time (more than a year) afterward. Coxa plana thus arises in a joint primarily normal.

Although the subject of *treatment* is not strictly within the limits of this paper, the author cannot refrain from warning against any radical operative procedure. In the beginning, coxa plana always shows in the roentgenogram only very slight lesions. The deformation of the head may be insignificant or marked, and no prediction can be made in this regard before the stage of fragmentation has set in,—that is to say, about one year after the beginning of the slight limping. Then one can see whether or not the necrosis of the epiphysis, and sometimes of the adjacent portion of the neck, is going to be extensive. *If anything is to be done,* it should be done before this period. It should be remembered that most cases heal with a deformity which is only slightly troublesome, at least up to fifty years of age. It is important, therefore, never to use any operative treatment, with the possible exception of drilling through the epiphyseal cartilage. The writer is not able to say whether or not this procedure is of any benefit, as he has used it in only a few instances and during a very short time.

The most important consideration is to treat these cases purely conservatively. The patients should be given from one to two months' rest in bed, after which they may be up and about on crutches for at least one year. It is necessary for most patients to stay at the hospital for one month in order to learn to walk with crutches. If any contracture develops, extension with adhesive tape is used until the contracture disappears; this usually requires from one to two months.

Plaster and immobilizing bandages should never be used. All such procedures tend to impair the circulation and nutrition in the joint and may, therefore, be injurious.

NOTE: After this paper had been presented, Dr. Murray S. Danforth, of Providence, Rhode Island, was kind enough to show the author his roentgenograms of patients who were treated with rest in bed for one year or more and then were allowed to walk with crutches. The writer thinks that Dr. Danforth's results in two cases were better than those which he obtained and he is now going to try this method of treatment.

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# THE RESULTS OF POSTURAL REDUCTION OF FRACTURES OF THE SPINE *

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Fractures of the spine include injuries to the vertebral bodies and the interarticular joints, avulsion fractures of the transverse processes, and contusion fractures of the spinous processes. This investigation concerns only the first of these groups of injuries.

## TYPES OF VERTEBRAL-BODY FRACTURES

Three types of vertebral-body fractures are to be distinguished: (1) simple wedge fracture; (2) comminuted fracture; and (3) fracture-dislocation. (See Figures 1-A, 1-B, and 1-C.)

### *Simple Wedge Fracture*

Wedging of vertebrae is due to a diffuse bending force with vertical compression, and, as a rule, more than one vertebral body is involved. The reduction in the anterior depth with forward bulging of the cortex at the upper or lower angles is often obvious in two, three, four, or even

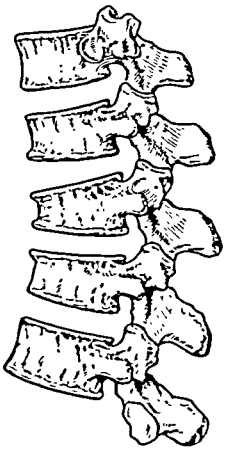


FIG. 1-A

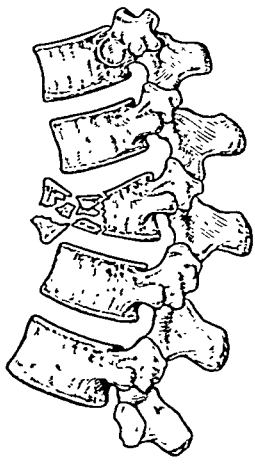


FIG. 1-B

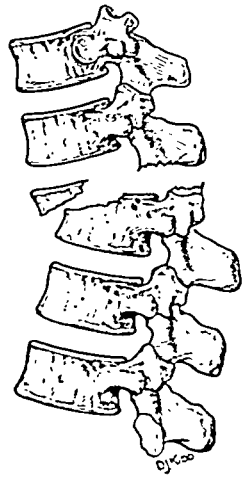


FIG. 1-C

Three types of flexion compression fractures of vertebral bodies.

Fig. 1-A: Simple wedge fracture by diffuse bending or vertical compression; several bodies are involved; the discs are normal; ankylosis is rare. (151 cases.)

Fig. 1-B: Comminuted fracture by acute angulation; one body only is involved; the disc is ruptured; ankylosis is common. (33 cases.)

Fig. 1-C: Dislocation of the intervertebral joint with fracture of the neural arch; the cord is compressed or severed; there is a secondary fracture of the body below. (68 cases.)

* Read in abstract at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

five vertebrae in the initial roentgenogram. In other cases, the obvious injury appears to be confined to one vertebra, but actual measurement of the roentgenograms shows slight diminution of the anterior depth of the bodies above and below. There is no fracture of the pedicles or of the laminae, and forward tilting of the bodies is possible only through movement of the interarticular joints. Since several vertebrae are involved, no one interarticular joint is actually dislocated, but several may be strained.

*Comminuted Fracture*

This fracture is due to more acute and localized injury. There is such sharp angulation at one intervertebral-disc level that the anterior angle of one of the vertebral bodies is driven into the middle of the adjacent body. Even if the spine has been partly extended again, the triangular-shaped depression of the intervertebral surface of the fractured body corresponds so exactly in size and shape to the angle of the adjacent vertebra that the mechanism of injury is obvious. (See Figure 5-D.) Occasionally both upper and lower surfaces of the fractured body are similarly depressed; the vertebra above and the vertebra below have almost met in the middle, and anterior marginal fragments may have been squeezed forward. (See Figure 7.)

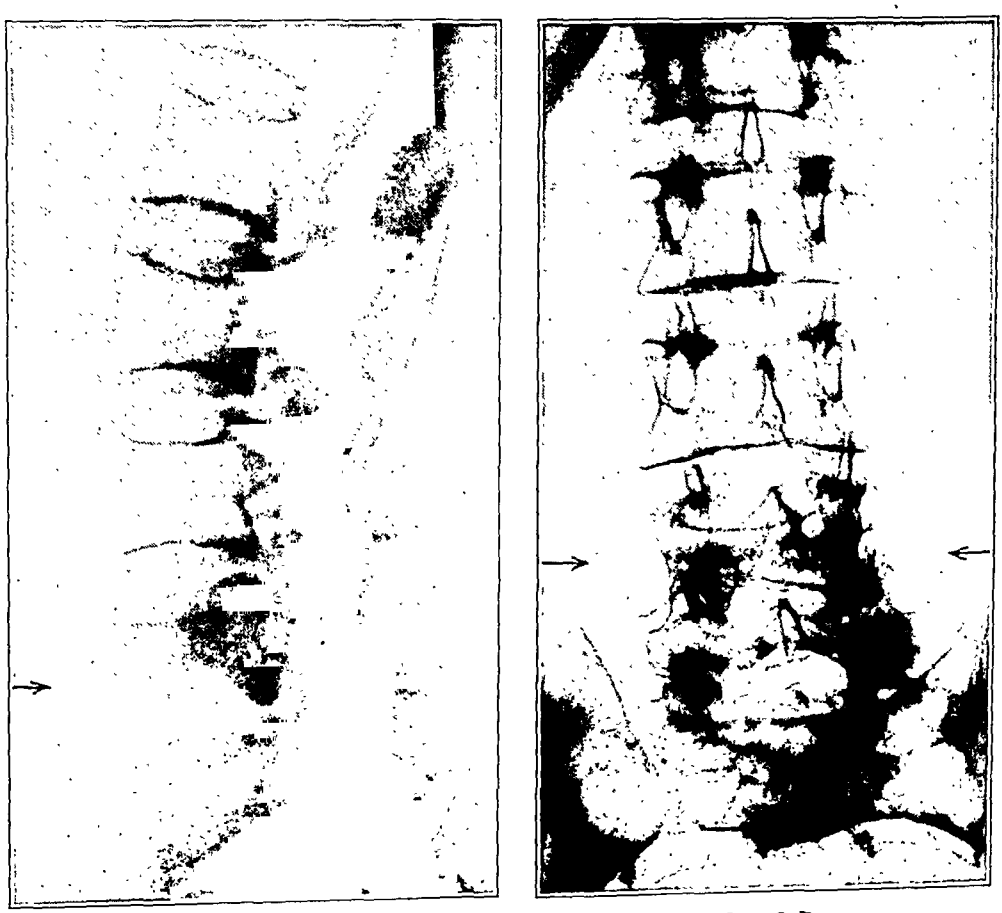


FIG. 2-A FIG. 2-B

Spontaneous fracture of the spine in senile osteoporosis.

The angle of the impacting vertebral body has frequently impaled and ruptured the intervening disc, forcing it between the bony fragments. Narrowing of the intervertebral-disc space is seen more commonly in this than in any other type of fracture of the spine. With an injury so localized, one or perhaps two interarticular joints take the whole strain of the displacement, and the interarticular-joint injury is even more serious than in simple wedge fractures. Nevertheless, persistent pain is less common in unreduced comminuted fractures, because the rupture of the intervertebral disc promotes bony ankylosis between adjacent vertebral bodies, a sequela which is rarely seen in wedge fractures.

*Fracture-Dislocation*

This injury is primarily an intervertebral dislocation, with trauma to the neural arch, which allows the upper segment of the spine to dislocate forward. The displacement is such that the spinal cord is compressed, attenuated, or severed. The neural-arch injury may be a bilateral dislocation of the interarticular joints, a bilateral fracture of the laminae or of the pedicles, or a combination of these injuries. As the upper segment of the spine displaces forward, the vertebral body below may be secondarily wedged or comminuted, or a fragment may be detached from its upper margin.

An investigation of 252 vertebral-body fractures shows that simple wedging of one or more vertebrae is the most common injury, and comminuted fracture is the most rare.

| *Type* | *No. of Cases* | *Per Cent.* |
|---|---|---|
| Simple wedge fracture | 151 | 60 |
| Comminuted fracture | 33 | 13 |
| Fracture-dislocation | 68 | 27 |
| Total | 252 | 100 |

ETIOLOGY OF VERTEBRAL-BODY FRACTURES

All three types of fractures are due to hyperflexion and compression strains.

| *Type of Accident* | *No. of Cases* | *Per Cent.* |
|---|---|---|
| Patient fell from a height | 146 | 58 |
| Weight fell on the patient | 45 | 18 |
| Motor-car accident | 33 | 13 |
| Other mechanism (or unknown) | 28 | 11 |
| Total | 252 | 100 |

The classic accident is the fall of a weight on the back of the patient's shoulders. This produces acute flexion of the spine, and is usually responsible for comminuted fractures and fracture-dislocations. Less than one-quarter of the cases in this series were of this type, and most of these patients were coal miners, the victims of falling roofs.

The simple wedge fractures are more often attributable to vertical

compression of the spine, due to a fall on the feet or on the buttocks. The industrial activities of a large city may explain the frequency of falls from a height. In smaller towns, close to arterial roads, a higher proportion would no doubt occur from motor accidents. More than half of the patients in this series fell from scaffolding, from cranes, from ships' sides and ships' decks, from ladders, and from roofs. Some fell in the standing position,—as, for example, the sailor who fell down the inside of a ship's mast and also fractured both heels. Routine examination of the spines of patients who have sustained a crush fracture of the os calcis has on several occasions disclosed an unsuspected wedge fracture of the vertebrae. Some patients fell on the buttocks in the sitting position, like the two victims of an aeroplane crash who sat one in front of the other in the cockpit; both sustained fractures of the lumbar spine.

The miscellaneous group includes one case where the mechanism was the opposite of a fall in the sitting position. A girl sat on the deck of a motor launch, and an explosion beneath the deck blew her into the air, fractured her spine, and flung her forty yards into the sea. Despite complete paraplegia, she swam to a dinghy, escaped drowning, and ultimately recovered. In several cases, senile osteoporosis predisposed the patients to fractures of the spine from relatively trivial injuries. An elderly doctor was stooping to lift a moderately heavy weight when he felt a crack in his back; roentgenographic examination showed severe crushing of the fourth lumbar body. (See Figures 2-A and 2-B.)

*Fractures of the cervical spine* occurred more commonly from the fall of a weight on the back of the head, and from motor accidents. A woman was the passenger in a car which stopped very suddenly at a robot signal; her head was jerked forcibly forward and, although it was not struck in any way, a cervical interarticular joint was dislocated. Two men were the victims of rugby-football accidents. In both cases the players were locked in a scrummage which collapsed; their heads were forced down by the weight of other players, their cervical spines were dislocated, and both died from the complications of paraplegia.

## TECHNIQUE OF REDUCTION AND IMMOBILIZATION

The series includes ninety-four personal cases treated mainly by the technique first described in 1930[4], which consists of postural reduction (without general anaesthesia) by prone suspension between two tables, the application of a plaster jacket, and early ambulatory activity. Other methods which have been employed include the heel-suspension technique of Davis[1], extension of the spine by pumping up the kidney bar of an operating table over which the patient lies supine, and pulley extension by a canvas sling on which the patient lies prone.

The various methods of reduction may be divided into two groups:

1. The trunk is wholly unsupported; the patient lies prone, and the spine sags into maximum hyperextension (Figs. 3-A and 3-B).

2. The trunk is supported in the extended position; the patient lies

prone on a canvas sling or Roger's frame[3], or supine on an extended spinal frame, curved strip of metal, kidney rest, motor jack, etc. (See Figure 4.)

Whereas in the first group of methods the unsupported trunk finds its own limit of hyperextension, in the second the surgeon determines the degree of extension and supports the trunk in that position. Is there any essential difference in the effectiveness of these methods?

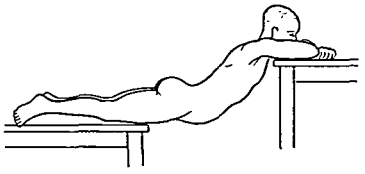


FIG. 3-A

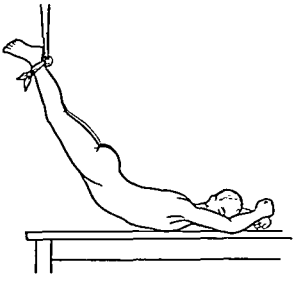
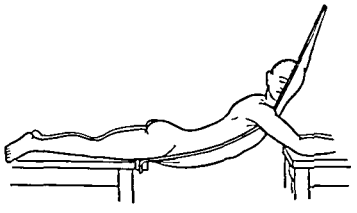
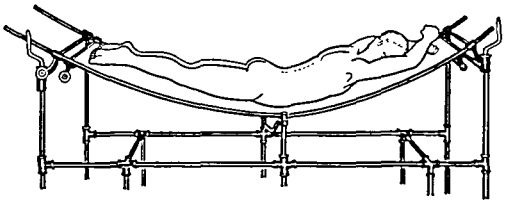


FIG. 3-B

Adequate methods of reduction. The trunk is unsupported; the pelvis tilts forward; and the lumbar spine must sag to the limit of hyperextension. Fig. 3-A: Watson-Jones technique. Fig. 3-B: Davis technique.







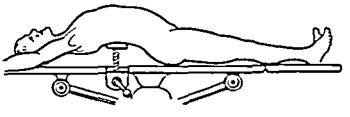


FIG. 4

Relatively inadequate methods of reduction. The trunk is supported in a controlled degree of extension. The pelvis does not fully tilt forward, and the normal limit of hyperextension is not attained.

Reduction depends on the tension of the anterior longitudinal ligament. It is not enough that the spine is extended. It must be hyperextended, and it must be hyperextended to the normal limit. Not until this limit has been reached does the anterior longitudinal ligament become sufficiently taut to complete the reduction, and, still more important, to maintain the reduction. Only if the limit is reached and maintained is it impossible for the vertebral body to collapse whether or not the patient is ambulatory.

The normal range of extension movement varies in every patient. One patient, of the short, thickset type, may have reached the limit at 20 degrees, but another patient must hyperextend the spine 60 degrees

normal individual. That is something upon which we are now working. Wright's work on opsonins demonstrated that the opsonic index could be raised by the administration of a vaccine.

In view of the extreme virulence of the staphylococcus toxin, it would appear that a high degree of natural antitoxin in the blood would be an excellent defense against its ravages. Ninety per cent. of deaths from staphylococcal osteomyelitis occur in the first two weeks.[7] While a high degree of natural antitoxin may not be a factor in the direct destruction of organisms, yet it is not unreasonable to suppose that the neutralizing of the toxin will allow other defensive agents to have an unimpaired action in the destruction of organisms. In this way, then, the first organisms that gain entry to the blood may be destroyed or rendered innocuous soon after their entry.

TABLE VII

ANALYSIS OF NINE CASES IN WHICH STAPHYLOCOCCUS ANTITOXIN WAS INJECTED INTRAVENOUSLY

| Case No. | Age | Diagnosis | Date of Admission | Date of Injection of Antitoxin | Result |
|---|---|---|---|---|---|
| 77985 | 12 years | Osteomyelitis of ilium | May 16, 1935 | May 18, 1935 | Improved |
| 71219 | 12 years | Osteomyelitis of left tibia | September 22, 1933 | September 22, 1933 | Died, September 23, 1933 |
| 67310 | 5 years | Osteomyelitis of left tibia | October 12, 1932 | October 17, 1932 | Died, October 18, 1932 |
| 78045 | 9 months | Osteomyelitis of mandible | May 20, 1935 | May 27, 1935* | Died, May 29, 1935 |
| 61149 | 10 years | Osteomyelitis, multiple lesions | August 6, 1932 | August 6, 1932 | Died, August 7, 1932 |
| 40078 | 10 years | Osteomyelitis of left femur and left humerus | December 5, 1932 | December 5, 1932 | Improved |
| 55487 | 9 years | Osteomyelitis of left femur | September 1, 1932 | September 1, 1932 | Died, September 8, 1932 |
| 67039 | 2 years | Cellulitis septicaemia | September 26, 1932 | September 26, 1932 | Cured |
| 66336 | 11 years | Osteomyelitis of right clavicle and left pubis | July 29, 1932 | July 29, 1932 | Improved |

* This patient received 20 cubic centimeters of staphylococcus-aureus bacteriophage intramuscularly, 70 cubic centimeters of staphylococcus-aureus bacteriophage intravenously, and 100 cubic centimeters of staphylococcus antitoxin intravenously.

before the ligament is normally taut. The use of any curved surface on which the patient lies, presumes that the same degree of extension will correct every fracture, and this is not so. If a motor jack or kidney rest is pumped up beneath the kyphos, the surgeon cannot know when the limit of extension has been reached. If a ventral sling or hammock is used, imperfect reduction is particularly common. The sling prevents the tight stretched feeling in the abdominal wall, but, in so doing, it has limited extension movement, prevented forward tilting of the pelvis, and interfered with complete reduction.

For these reasons, the original technique—in which the trunk is entirely unsupported from the arms to the thighs, so that it must sag into space to the limit of the patient's extension movement—is still preferred as the routine treatment for lumbar and thoracolumbar fractures. If the injury is of several weeks' duration and anaesthesia is required, the technique of Davis is more convenient. Only in high thoracic fractures, where lumbar extension is not required and where direct pressure under the kyphos is more effective, is the pumped-up kidney bar of an operating table used. At this high thoracic level, perfect reduction is difficult and sometimes impossible, whatever technique is employed.

## RESULTS OF TREATMENT

### *Wedge and Comminuted Fractures*

The personally treated cases have been reexamined and check-up roentgenograms have been taken twelve months or longer after injury. The investigation shows that in lumbar and low thoracic fractures there is no difficulty in correcting wedging and in preventing redisplacement. In two-thirds of the cases, the final wedging either cannot be measured in the roentgenograms or does not amount to more than one-eighth of an inch. In only 7 per cent. of the cases was the method so ineffectively applied that the final wedging was more than one fourth of an inch. (See Figure 5-D.) The roentgenographic findings twelve months or longer after injury in these sixty-seven personally treated cases of wedge or comminuted fractures were as follows:

| *Findings* | *Per Cent.* |
|---|---|
| Wedging or collapse of vertebral bodies: | |
| Not measurable | 32 |
| One-eighth of an inch or less | 36 |
| One-quarter of an inch | 25 |
| More than one-quarter of an inch | 7 |
| Integrity of intervertebral discs: | |
| No narrowing of disc space | 80 |
| Narrowing of disc space | 20 |
| Spur formation at vertebral-body margins: | |
| None | 78 |
| Trace | 20 |
| Severe | 2 |



FIG. 5-A



FIG. 5-B



FIG. 5-C



FIG. 5-D

Roentgenograms of typical cases one year or longer after adequate treatment.

Fig. 5-A: Example of multiple wedging; four vertebrae were involved. The final wedging cannot be measured. (32 per cent. of the cases.)

Fig. 5-B: Final wedging one-eighth of an inch. (36 per cent. of the cases.)

Fig. 5-C: Final wedging one-fourth of an inch. (25 per cent. of the cases.)

Fig. 5-D: Example of a comminuted fracture; the disc is ruptured; there is bony ankylosis. Final wedging more than one-fourth of an inch. (7 per cent. of the cases.)



FIG. 8

Fracture-dislocation of spine. No attempt was made to reduce the deformity "because the patient was paraplegic". Although the paraplegia has fully disappeared, the deformity and pain are such that the patient is still totally incapacitated.



FIG. 9

Dislocation of cervical spine with nerve-root pressure. The failure in this case was due to faulty reading of roentgenograms which had been interpreted as "showing no bone injury".

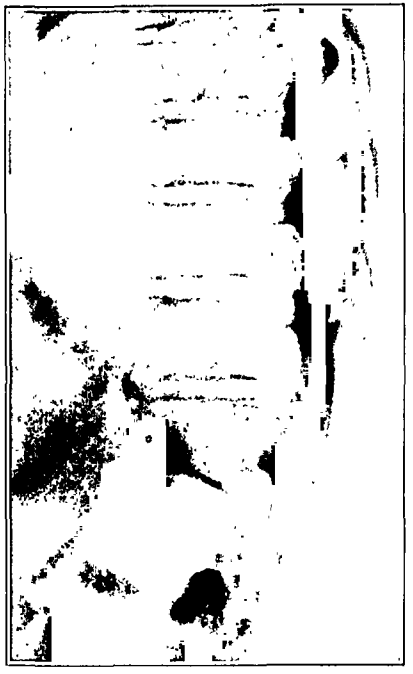


FIG. 10

Fracture treated on spinal frame. Patient had been told that "one-eighth of an inch more would have meant paralysis". After twelve months of recumbency, he was told "not to walk very much", and "never to go out without his wife". He is a nervous wreck and will never work again.

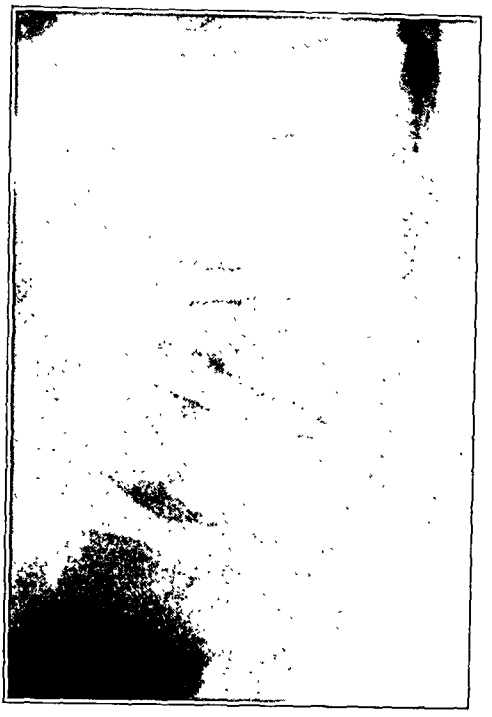


FIG. 6

Wedge fracture after inadequate treatment. The discs are normal, and there is no tendency to ankylosis. There is still severe aching pain six years after injury, due to interarticular-joint strain.

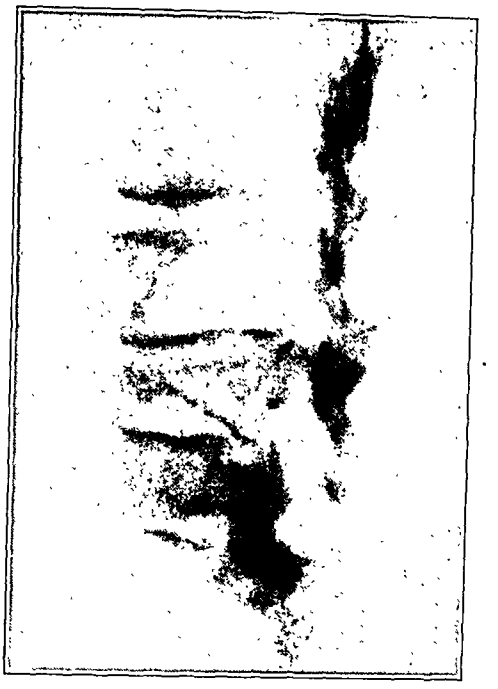


FIG. 7

Comminuted fracture after inadequate treatment. Both discs have been ruptured, and there is bony ankylosis. Despite deformity, there is no pain.

Such a degree of anatomical accuracy in the results is far less evident in the 117 cases examined months or years after treatment elsewhere. (See Figures 6 to 11.) Attempts to reduce the fractures and to apply plaster jackets had sometimes been made, but wedging was the rule, not the exception. It varied in degree from reduction by one-third in the anterior depth to almost complete disappearance of the anterior margin of the body. (See Figure 6.)

### *Significance of Uncorrected Wedging*

Does it matter if the fracture unites with wedging? Is wedging responsible for persistent pain or for any other disability? Even when the fragments have united in relatively good position, some patients complain of persistent pain. In only two-thirds of the cases in which good reduction was obtained was there complete absence of pain, with an assurance from the patient that the spine was as good as before the accident. Thirty per cent. of the patients complained of occasional discomfort or pain, and 4 per cent. complained of frequent or severe pain. But in the other series, where there was more marked deformity, almost every patient complained of considerable pain. The complaint was quite monotonous in its regularity. Many patients were seen years after injury, long after the conclusion of all medicolegal dispute, still complaining of serious pain.

There can be no doubt that severe wedging of one or more vertebrae throws the interarticular joints out of alignment and causes persistent

their original employment. More than half of this proportion (48 per cent.) were men engaged in heavy labor and less than half (32 per cent.) were artisans, light laborers, or sedentary workers. The other 20 per cent. maintained that they were partially or totally disabled: 8 per cent. could do light work only, and 12 per cent. could do no work. The men engaged in heavy labor were incapacitated for an average period of ten months and those in lighter employment for seven months. In most cases the plaster jacket was worn for from four to six months. It is evident, therefore, that from three to six months of treatment have been necessary after the jacket was discarded before recovery was complete.

In considering both the duration of disability and the frequency of permanent incapacity, it must be recognized that many of these patients are men past middle age, who have fallen from fifty to 100 feet and have suffered mental as well as physical injury. For example, one workman is classified with the 12 per cent. who were totally incapacitated, because, after a few weeks at work, he refused to go into dangerous situations. Consequently, he was discharged and has been unemployed ever since. He admits that, apart from occasional slight pain, his recovery is complete, but he is afraid of sustaining an even worse accident. It is probable that both the duration of incapacity and the frequency of permanent incapacity could be reduced by treatment in rehabilitation centers.

*Fracture-Dislocations with Paraplegia*

In the personally treated series there were twenty-seven fracture-dislocations with paraplegia. Of the nine patients with cervical injuries, three recovered; of the five patients with high thoracic injuries, only one recovered; and of the thirteen patients with lumbar and thoracolumbar injuries, eight recovered. This small series suggests that the prognosis is bad in high thoracic fracture-dislocations, but that in lumbar and cervical injuries recovery may be anticipated in about half of the cases. The outlook is obviously most favorable in injuries below the first lumbar level.

The cord damage may have been sustained at the moment of injury, or at any subsequent time that the patient was lifted by the shoulders and hips. (See Figure 12.) The danger of this movement, especially with the patient supine, was first pointed out by the author in 1931.[4] When a patient is to be lifted onto a stretcher, or from a stretcher to a bed, special precaution must be taken to avoid flexion of the spine. If, as in coal mines, the victim must be carried a considerable distance without a stretcher or other support, face-down transportation is advisable. (See Figure 13.) It is actually much easier to carry a helpless patient prone than supine, and the Swahili negroes have carried their victims of spinal injury in this way for many generations.

It is probable that the fate of the spinal cord is already sealed by the time the patient is lying flat in bed. Merely laying the victim on a flat surface has usually reduced the dislocation sufficiently to relieve actual

painful strain. The analogy of the malunited fractured spine with the painless kyphos so often seen in healed tuberculosis is fallacious. In healed tuberculosis, the angulated area has undergone fibrous or bony ankylosis. These cases are only comparable with comminuted fractures where there is a tendency to ankylosis (Fig. 7); they are not to be compared with the more common wedge fractures which show no tendency to ankylosis (Fig. 6).

*Significance of Narrowed Intervertebral Disc*

Slight narrowing of the disc space is sometimes seen above or below a fractured vertebra, and this may account for a trace of kyphosis even if there is negligible wedging of the bone. The narrowing is of minimal degree and it does not appear to be an important source of pain. Serious narrowing of the disc is more common in the comminuted fracture where the disc has been ruptured by the impact of the margin of the vertebral body above. In this series there is no case of proved retropulsion of an intervertebral disc. The complication may have occasionally been responsible for local pain in the back, but there was no patient with root pain or pressure symptoms of sufficient degree to warrant complete neurological investigation.

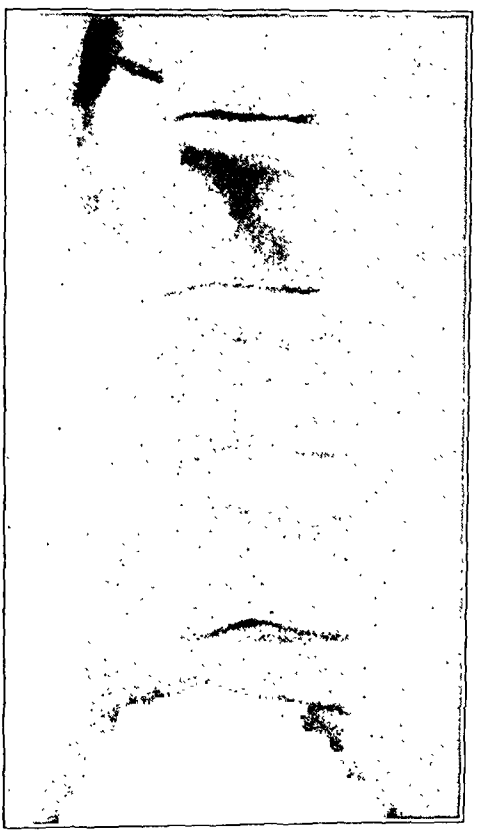


FIG. 11

Wedge fracture imperfectly reduced and inadequately immobilized in a short plaster jacket.

*Significance of Spur Formation*

The formation of bony spurs at the anterior margins of vertebral bodies is only well marked in unreduced fractures. Large spurs represent unreduced fragments of the crushed vertebral body; they were present in more than half of the indifferently treated cases (Fig. 6) and in only 2 per cent. of the cases in which good reduction was obtained. Slight spur formation, due to subperiosteal ossification in the attachment of the anterior longitudinal ligament, is seen more frequently, even after accurate reduction (Fig. 5-B), but this is not a source of pain and certainly does not indicate arthritic change as is so commonly assumed.

*Capacity for Work*

Analysis of the subsequent history in the sixty-seven cases of wedge and comminuted fractures shows that 80 per cent. of the patients resumed

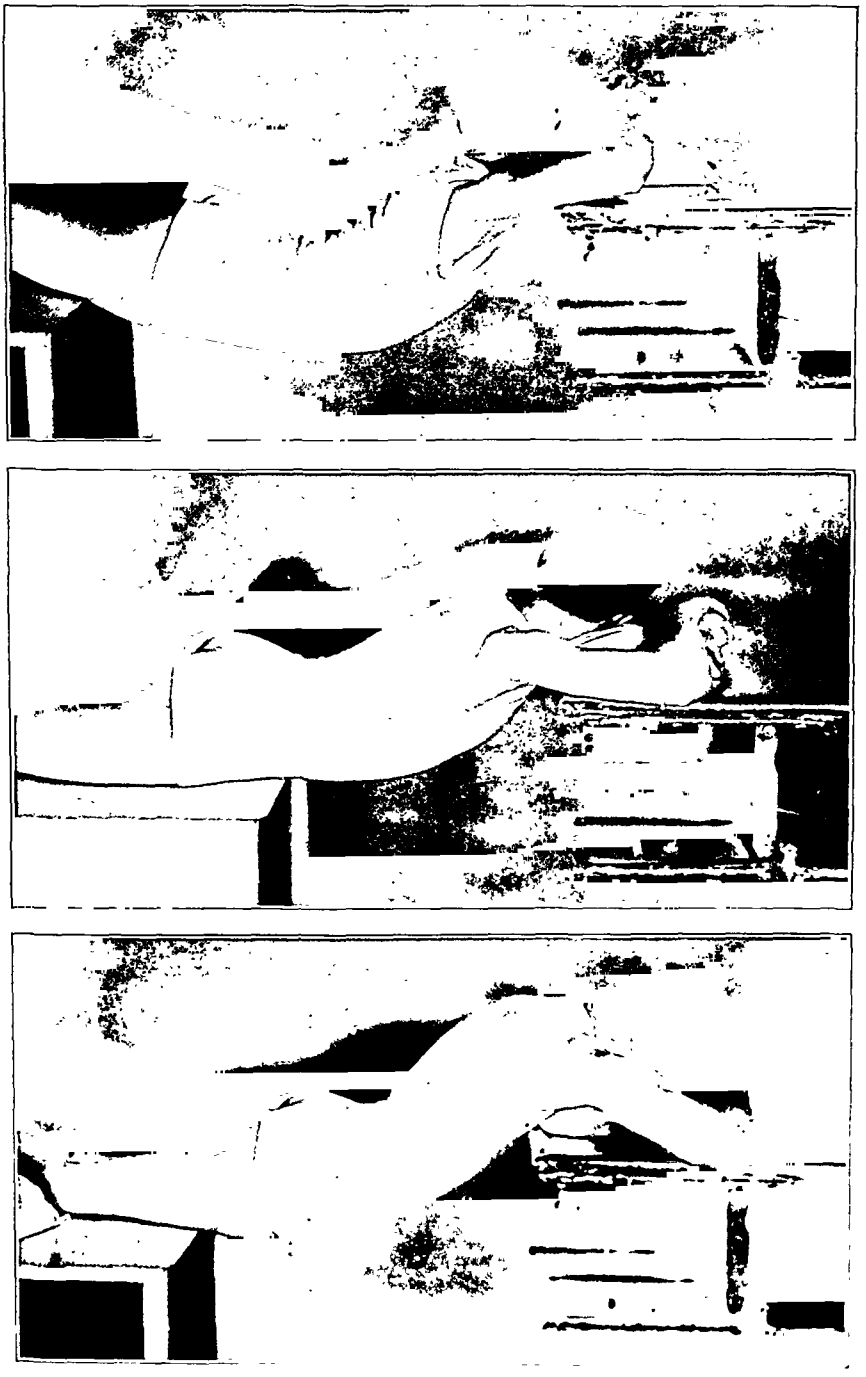


FIG. 14

*Upper:* Correct position for postural reduction.

*Middle:* Incorrect position. The lower table extends beyond the groins and prevents the pelvis from tilting forward. The lumbar spine is incompletely extended.

*Lower:* Incorrect position. The patient is too close to the upper table. The thoracic spine is incompletely extended and the jacket cannot be carried high enough. Displacement will recur.

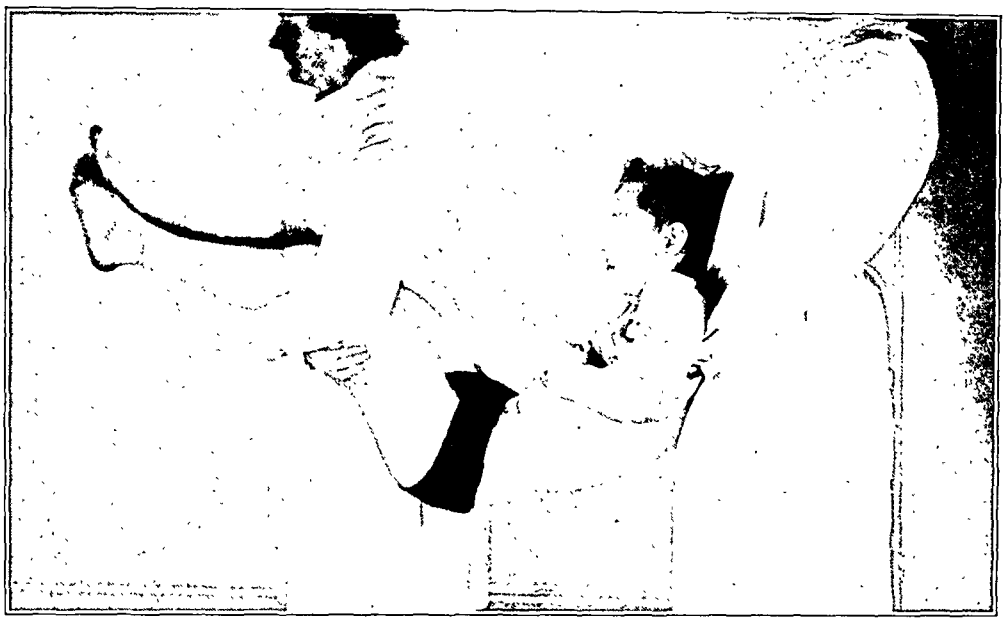


FIG. 12

If a patient with a thoracolumbar fracture-dislocation is carried face upward, the spine is forced into flexion and the injury must be increased.



FIG. 13

When no stretcher is available, face-down transportation is *relatively* safe.

bony pressure on the cord, so that the Queckenstedt test shows no obstruction to the free circulation of cerebrospinal fluid. If this flat position could be maintained uninterruptedly, it would probably be true to say that recovery from the paraplegia could not be promoted still further by hyperextension of the spine, which completes the last stages of reduction. However, it cannot be maintained. The demands of nursing are such that the patient is continually lifted, twisted, and turned. Under these

A study of the antihemolytic action of the blood in clinical cases where there is staphylococcal infection demonstrates various levels of this power (Table VI). In cases where there is a spontaneous rise, it comes on gradually and may reach great heights. It is reasonable to conclude that the infection stimulates defense in the increasing of antitoxin, and it appears equally true that when the natural antitoxin is at a high level the patient's general reaction is not great. It is said [5] that the administration of prepared antitoxin does not act as an antigen for the production of natural antitoxin, but it would appear that an antitoxin that is available would be a useful agent to introduce in the early stages of an infection into the blood stream of a patient suffering from staphylococcal disease. Unfortunately in our hands this line of treatment has given very questionable results (Table VII), so that it is the practice now not to give antitoxin intravenously. However, we do use it intramuscularly.

The height of the titer is not maintained over a long period in most cases. It quickly falls to a lower level and in a period of months is to be found at the base line,—this, too, in the presence of the infection. It is possible in these cases to raise the level by the administration of toxoid, and, while it is admitted that a titer above normal does not prevent a flaring up of the activity of organisms, it surely must be a factor in neutralizing or minimizing the effect of the toxin produced. We believe that the level of antitoxin should be kept at least three times normal in all cases of chronic or healed staphylococcal osteomyelitis. To this end, regular investigation of the patient's blood is made as frequently as is found to be necessary and toxoid is administered if there are less than three units of antitoxin present. We now have a special follow-up of this sort and hope that in a few years results will be available that will decide the question. We have had no experiences of an adverse nature with the administration of toxoid.

## PREVENTION

It should be possible to prevent bone lesions in children who are reasonably supervised by their parents. A child with a skin lesion should be given a course of toxoid, as skin lesions are not prone to stimulate the production of natural antitoxin in the individual. The child also should be limited in his activity to a point where he is not likely to suffer a strain or injury to a joint or bone, as injury and trauma are potent factors in determining the site of a local lesion.

## EXPERIMENTAL PATHOLOGY

In the past, there has been done a considerable amount of excellent experimental work which has given a fairly clear picture of the mode of infection and the site of the local lesions.

This disease has been known for ages to be associated with furuncles,—indeed, it has been called furunculosis of bone. Where a pathological process has caused vasodilatation and the consequent increase in blood supply there must be ample opportunity for the infecting organism to be

circumstances, increase in the deformity and aggravation of the local injury are inevitable. (See Figure 8.) Nursing is greatly facilitated, the liability of the formation of pressure sores is minimized, and pain is relieved by immobilization in a plaster bed or anterior plaster lid. If the spine is extended, cord pressure is controlled with far greater certainty than by laminectomy, and the necessary steps have been taken to ensure a painless undeformed spine if the patient should be fortunate enough to recover from the paraplegia.

### COMMON SOURCES OF FAILURE IN TREATMENT

It is becoming increasingly rare to find fractures of the spine in which no attempt has been made to correct the displacement because the injury was overlooked in the roentgenograms (Fig. 9) or because the surgeon was unfamiliar with the method. However, although in most cases plaster fixation has been employed, it is still very common to find incomplete reductions and very imperfect results. (See Figures 10 and 11.) The postural method of reduction and plaster fixation is so simple that there is some danger of ignoring the details which make all the difference between success and failure.

Many fractures have never been reduced. Although a plaster jacket has been applied, the spine has not first been fully hyperextended. Common sources of error are shown in Figure 14. If the lower table extends any higher than the thighs, the pelvis is supported and its forward tilt is minimized. In this event, the lumbar spine is imperfectly extended; either the fracture will be incompletely reduced or displacement will recur within a few weeks. Similarly, if the higher table is placed too close to the chest, the thoracic spine is incompletely extended, and the plaster jacket cannot be carried up to the clavicles. A plaster jacket applied in this position will inevitably permit redisplacement when the patient is allowed up.



FIG. 15

Correctly applied plaster cast, extending from the groins and the symphysis pubis to the clavicles. The lumbar spine cannot be flexed.



FIG. 16

Incorrectly applied plaster cast. It is cut too high at the groins and too low over the chest. Displacement of the fracture will recur.

Figure 15 shows a perfectly applied plaster cast. It extends from the symphysis pubis and the groins up to the clavicles. In this cast it is impossible to flex the spine, and displacement cannot recur whether or not the patient is ambulatory and practising exercises. If the patient complains that when he sits, or lies in bed, the plaster digs into the groins or presses in the neck, the surgeon must not cut away plaster until he can sit comfortably (Fig. 16); he must teach the patient how to sit and to lie, propped with pillows, so that he extends the trunk away from the plaster margins. The surgeon who was so kindhearted as to cut the plaster as generously as shown in Figure 17 should have been honest with himself and should have removed it altogether. The jacket is so short in front that it is not immobilizing the spine at all. Furthermore, the large abdominal window was cut before the plaster was hard, and the final result is that the patient can flex his spine almost as freely as if he were not in plaster at all (Fig. 18).

In other cases, far too much wool and felt protection has been used beneath the plaster. Even if the jacket is applied over a single layer of stockinet with a square of adhesive felt over the kyphos, it becomes very loose within a few weeks. In many cases a new jacket must be applied, again in the position of maximum hyperextension, from four to eight weeks after the original reduction.

Finally, in many cases, excellent primary treatment has been wasted because the jacket has been removed too soon. Crush fractures of verte-

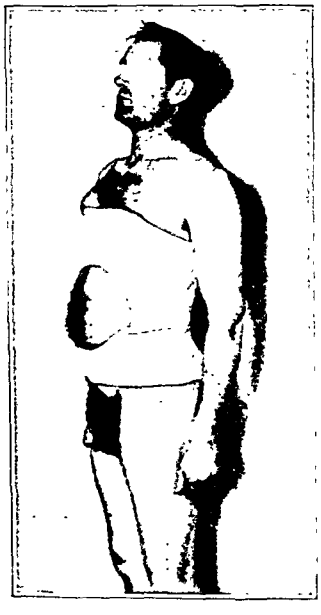


FIG. 17

A plaster jacket which is a pure ornament. It is not immobilizing the spine at all.



FIG. 18

The patient can flex the spine almost as freely as if he were not in plaster at all.

bral bodies are slow in consolidating, and it is unsafe to allow flexion movement in less than four months. The comminuted fractures are particularly slow in uniting, and in these cases the jacket should be retained for six months. It is a mistake to use a posterior spinal support at any stage of treatment. In early months it gives the surgeon a false sense of security. However well made and however heroically worn, a posterior support cannot prevent collapse of an unsoundly consolidated fracture. In later months it gives the patient a false sense of security. Many months or even years may elapse before he can be persuaded to discard a splint which is doing nothing except preventing him from stretching adhesions.

### HYPEREXTENSION FRACTURES

In 1934 the author described the first recorded case of hyperextension fracture of a lumbar vertebral body.[4] The intervertebral ligaments withstood the extension strain and remained intact; the vertebral body was comminuted; an upper anterior quadrant was tilted upward by the traction of the ligament above and a lower anterior quadrant tilted downward by the traction of the ligament below. Since that time, only one other hyperextension fracture has been seen, and this was of a different type.



FIG. 19

Hyperextension fracture of both pedicles sustained spontaneously by an acrobatic dancer.

An acrobatic dancer had taken up her profession at such a late age that it was always necessary for her to spend from ten to fifteen minutes loosening and "limbering" before going on to the stage. One night she was called on hurriedly. In the course of the dance she slowly hyperextended her spine until her head was almost between her knees. There was an ominous crack and an agonizing pain; she had fractured both pedicles of the neural arch of the first lumbar vertebra (Fig. 19). Despite immobilization in plaster for many months, the fractured pedicles failed to unite by bone. A firm fibrous union developed. The patient pursues all normal recreations without symptoms and still has more than normal mobility of the spine, but she has not resumed professional dancing.

These two cases are the only known exceptions to the rule that lumbothoracic fractures are produced by hyperflexion and must be reduced and immobilized in hyperextension. There is, however, a type of lumbar fracture-dislocation in which caution is necessary because the articular processes are locked.

### LUMBAR FRACTURE-DISLOCATION WITH LOCKING OF ARTICULAR PROCESSES

When an intervertebral joint is dislocated, the upper segment of the spine can move forward because there is also a neural-arch injury. This may be a fracture of the base of the articular processes, a dislocation of the interarticular joints, or a combination of these injuries. If either articular process is fractured, the bones usually slide comfortably into position when the spine is hyperextended, and reduction offers little difficulty. If both interarticular joints are dislocated and there is no lateral shift or rotation of the upper segment, there may again be little or no difficulty in reducing by simple hyperextension. On the other hand, if the upper segment of the spine has not only slid forward but also to one side, the descending articular process of the upper vertebra is now actually locked in front of the ascending process of the lower vertebra on that side. (See Figure 20.) If the spine is hyperextended without first correcting the lateral shift, the upper articular process cannot slide back. The spine hinges backward, pivoting on the articular process; the vertebral bodies separate from each other; the intervertebral space is unduly widened; and the cord injury may be increased by stretching and attenuation. (See Figure 21.)

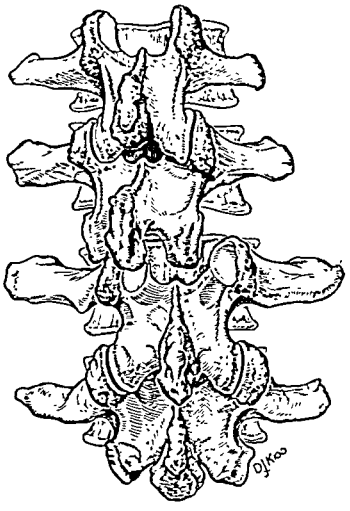


FIG. 20

The upper articular processes slip forward and laterally; the lateral shift is responsible for locking with the lower articular process on one side.

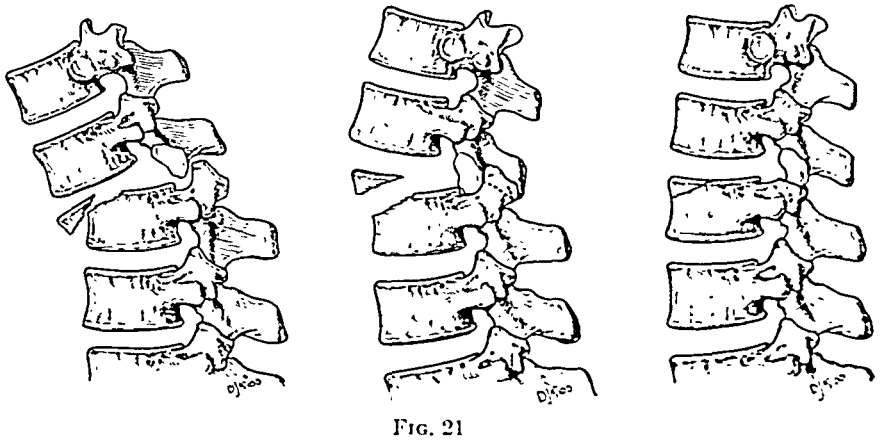


FIG. 21

Lumbar fracture-dislocation with locking of the articular processes. If the spine is hyperextended, the upper processes cannot slide backward, the spine pivots on the articular process, the vertebral bodies are separated, and the cord damage may be increased by stretching.



FIG. 22-A

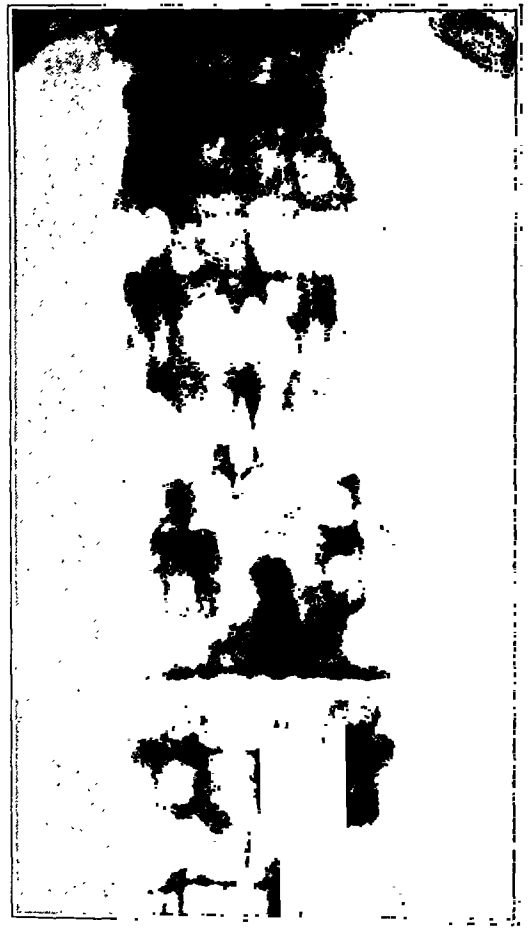


FIG. 22-B

The upper articular process of the lower vertebra on the side toward which the upper segment of the spine has moved must be excised before the spine is extended.



FIG. 23

The same case as shown in Figs. 22-A and 22-B. The spine has been hyperextended without first excising the articular process. The dislocation has not been reduced, and the cord injury has probably been increased by attenuation.

Before the spine is hyperextended, it is essential to expose the lamina and articular process of the vertebra below the dislocation, on the side toward which the upper spinous processes are deviated (by lateral shift or by rotation). The articular process is unduly prominent and it must be removed as close to its base as possible. The dislocation is then easily reduced by hyperextension because there is no longer any obstruction to the descending articular process of the upper vertebra; it can then slide backward and toward the mid-line.

The decision that operative treatment is essential must be made not only on the lateral roentgenogram, which shows the upper articular processes in front of the lower, but also on the anteroposterior roentgenogram, which shows the lateral or rotatory deviation. (See Figures 22-A and 22-B.) In the upper lumbar region, where the axis of the interarticular joints is in the frontal plane, the forward displacement of the upper articular processes has occurred not by "jumping" the lower processes, as may be seen in cervical dislocations, but by simply sliding forward. It is the secondary lateral or rotatory deviation which locks the processes. If in this region the anteroposterior view shows that the two upper processes still lie exactly between the two lower processes without any lateral or rotatory shift, reduction will probably succeed even though the lateral view shows the upper processes in front of the lower. A cautious attempt at reduction should be made, and check-up roentgenograms should be taken as the spine is gradually extended.

In the lower lumbar region the axis of the interarticular joints is not wholly in the frontal plane; indeed, it may be entirely in the lateral plane. In this region true jumping of the processes over each other occurs. Operative treatment is then essential, and it may be necessary to remove the articular processes of the lower vertebra on both sides.

## SUMMARY

1. *Types of vertebral-body fractures.* This series of 252 fractures are classified in three groups,—simple wedge fracture, comminuted fracture, and fracture-dislocation. The simple wedge fracture is the most common and is due to a fall from a height, landing on the heels or the buttocks. It is often multiple; the intervertebral discs are uninjured; and spontaneous ankylosis is rare. The comminuted fracture is the most rare and is caused by forcible acute angulation. The intervertebral discs are ruptured, and bony ankylosis is common. Fracture-dislocation is due to the fall of a weight on the shoulders, and the spinal cord is usually injured.

2. *Methods of reduction.* The spine must be hyperextended to the normal limit. The position varies considerably in different patients; therefore, fixed or controlled degrees of extension by slings or curved surfaces are imperfect. The trunk should be entirely unsupported, so that it sags into space to the limit of the patient's extension movement.

3. *Results of treatment.* In the wedge and comminuted types of

fractures, excellent anatomical results are possible by the postural method. Two-thirds of the patients reported that their spines were as good as before they were injured; 80 per cent. resumed their original occupations. The average period of incapacity for those engaged in heavy labor was ten months; for those engaged in light labor, seven months. In fracture-dislocations, immobilization in extension is advisable; laminectomy is not advisable. The prognosis is bad in high thoracic dislocations with paraplegia, fair in cervical injuries, and good in lumbar injuries.

4. *Common sources of failure.* Uncorrected wedging causes persistent pain, due to interarticular-joint strain. Neglect of minor details of the technique of postural reduction causes failure. The jacket must not be cut below the clavicles or above the groins. The cutting of an abdominal window is not advisable. Early ambulation is quite safe. The jacket must be renewed after a few weeks. The patient should be immobilized for from four to six months. Posterior spinal supports are inadvisable.

5. *Hyperextension fractures.* These fractures are very rare. In the two cases described, one was a fracture of the vertebral body and the other was a fracture of the pedicles.

6. *Fracture-dislocation with locking of the articular processes.* In lumbar fracture-dislocation with bilateral dislocation of the interarticular joint, lateral shifting of the spine may lock the articular processes. If the spine is hyperextended, reduction fails and cord injury may be increased by stretching. One and rarely both of the lower articular processes must first be excised.

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# THE HEALING OF FRACTURES OF ATROPHIC BONES*†

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Atrophy of bone signifies local, regional, or generalized wasting of the osseous tissues. This may result from disuse following paralysis, from long immobilization, from faulty absorption or faulty utilization of calcium and phosphorus, or it may be produced by a deficiency of these elements in the diet. In the growing child atrophy of bone is characterized by a relative decrease in diameter and in length, as well as by a decrease in density resulting from osteoporosis. When the condition is produced in the adult, it is manifested only by the porosis and attendant thinning of the supporting cortex of the bone or bones involved, while the actual size of the bone is not affected. Atrophy, which may result from disuse, change in blood pH by feeding ammonium chloride or similar acid-producing compounds, parathormone injection, hypervitaminosis D, diets deficient in minerals or vitamins, or total starvation, is much more readily brought about in growing experimental animals or in children than in adults.

Many clinicians, as well as scientists who are primarily concerned with laboratory research, have attempted to determine the importance of calcium and phosphorus or of vitamin D in the diet in the healing of fractures. They have expressed conflicting opinions concerning the healing of fractures in atrophic or osteoporotic bone. Interpretations of laboratory studies have differed widely, and in many instances results reported by one group have directly contradicted the conclusions of other clinical and experimental observers.

Murray states that fractures in osteoporotic bones heal promptly. Westphal and Hagemann have presented series of twelve and four clinical cases, respectively, and agree with Murray. Westphal's clinical series includes fractures in extremities in which atrophy had resulted from tuberculosis of the hip and the attendant immobilization. Westphal agrees with other writers who have concluded that these fractures in atrophic bones heal rapidly. The exciting trauma, the displacement of the fragments, and the symptoms are minimal. Tumpeer and McNeally, on the other hand, cite two cases of fractured atrophic bones in poliomyelitis, and conclude that, while callus formation does occur, the union is definitely

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weak, and in each of their patients there were recurrent fractures at the same site.

Experiments have been conducted on the effects of an excess or a deficiency of calcium in the diet; the importance of the quantity of calcium and phosphorus salts in the blood; the importance of local calcium depots, of the periosteum, and of vitamin D in the healing of fractures. Observers who have conducted quite similar experiments have often reported conflicting results. Downs concluded that an organic form of calcium phosphate in the diet produced better healing of fractures of the tibia than did an inorganic salt of calcium. Robb fed varying amounts of calcium and phosphorus to rats without any definite effect upon the healing of fractures, and Speed completed similar experiments in dogs, with the same conclusions. On the other hand, Berkheiser studied clinically the results of the feeding of mineral salts and completed one experiment with what he thought were beneficial results. However, a careful analysis of his case reports and a study of the roentgenograms of the healing fractures of the rabbit used in his experiment leaves room for considerable doubt in the mind of the reader.

An excellent review of the subject of the effect of the addition of calcium and phosphorus and of vitamin D to the diet upon fracture healing in the experimental animal may be found in an article by Fischer and Key. These authors reported that the addition of vitamin D and of calcium to the stock diet of the experimental animal would not lessen atrophy of disuse or accelerate the rate of union of bones. Significant was the finding of Roegholt that an insufficient amount of vitamin D caused delayed union, but he made no observations on the effect of an excess of vitamin D in the diet.

Downs and McKeown have shown that low-calcium diets may prolong healing and produce weaker union in fractured bones. Vitamin D in therapeutic doses has been reported by Grauer to help union, while overdoses have retarded repair. Swart, on the other hand, found that vitamin D did not influence fracture healing in any respect.

The importance of a rich local calcium depot, which can only be found in well-ossified bones, has been acclaimed by some to be the most important single factor bringing about fracture healing, while others [12, 16, 20] consider the question of local calcium depots to be without significant importance. Kernwein recently demonstrated that fractures in starving rabbits form fibrous callus and beginning bone trabeculae, but later the healing process halts and absorption of bone begins. In the animals that lived for thirty days or more, the bones of the skeleton became extremely osteoporotic and the initial callus itself underwent absorption.

In our own laboratory, experiments [5] have been completed which definitely showed delayed union, poor union, or non-union of fractures in animals with active rickets. Union occurred promptly in rachitic rats when vitamin D was added to the diet, but fractures of the long bones of rats fed a normal diet did not obtain more rapid union, or better union,

when excess amounts of vitamin D were added to the normal control diets. Urist, working independently, also found that active rickets delayed fracture healing.

The question of the influence of bone demineralization upon fracture healing seemed sufficiently unsettled to warrant further investigation. We were impressed by the bone atrophy and retardation of fracture healing which occurred in the rabbits which were starved in the experimental work of Kernwein. Fibrous union occurred in these fractures, but subsequently, and attendant upon the development of generalized osteoporosis, there was absorption of the lime salts from the callus. To us the hypothesis that a balanced ratio between the intake and the output of calcium and phosphorus, of vitamin D, and of the other elements of nutrition found in the stock diet is necessary for satisfactory healing of fractures seemed to be based upon reasonable presumptive evidence. The question of the relative amounts of these substances in the ideal diet for bone repair remained unsettled.

In the animals with active rickets, when vitamin D was added to the diet, healing of fractures was attended by rapid healing of the metaphyseal regions, with an increase in the diameter of the shafts, in the thickness of the cortices, and in the size of the trabeculae of the bones. It seemed advisable to try to settle the question of whether or not the delay in union in untreated animals showing active rickets resulted from the deficiency in the amount of bone fractured (osteoporosis) or in the specific pathology of rickets, of which the porosis was only a part.

## CLINICAL STUDIES

An attempt was made to determine whether or not the fractures of atrophic bones of patients treated at the University of Chicago Clinics had united at the same rate and to the same extent as had fractures of normal bones of patients of similar ages. Atrophy was either regional, involving only the extremity in which the fracture had occurred, or a generalized osteoporosis. In the series studied, there were ten cases of fracture and seventy-seven cases of osteotomy of atrophic long bones. We found that it was impossible to compare accurately the rate or degree of healing as shown in the roentgenograms of these patients. The size of the callus has long been known to depend principally upon the degree of periosteal tear and the size of the hematoma formed at the site of the fracture, and is not a satisfactory indication of the degree and the rate of fracture healing. We attempted to study the length of time required for actual bony union to occur, as evidenced by trabeculae which crossed the line of fracture. This is the method of determining union which has been recommended by Häbler and Reiss. However, after reviewing all cases of fractures of atrophic bones, we found that too many variables were present to make possible a satisfactory scientific comparison or analysis. (See Figures 1 and 2.) The following difficulties in interpreting the degree of fracture healing in cases such as these can be enumerated:

1. The variation in the ages of the patients;
2. Irregular intervals between roentgenographic check-ups;
3. The difference in location of the break or osteotomy;
4. The difference in time or intensity of the roentgen-ray exposure;
5. The difficulty in interpreting the degree of union from a roentgenogram;
6. Variations in the individual character or quality of the bone in the different patients.

Although our observations could not be made with scientific accuracy, the impression gained from this study was that union occurred as readily in fractures of atrophic bones as in fractures of bones of normal density. The osteotomies also healed promptly.

As had been shown by Fischer and Key, arthrodesing operations upon the feet of patients who had had infantile paralysis, and whose bones in

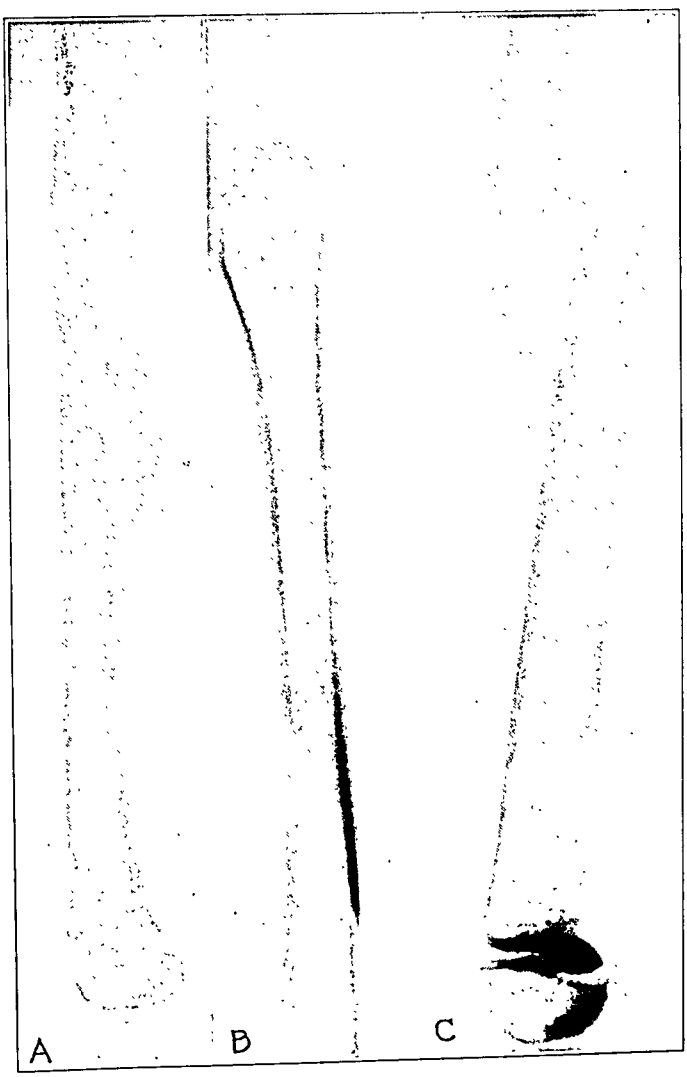



FIG. 1

FIG. 1

These roentgenograms illustrate the difficulties encountered in attempting to compare the rates or degrees of healing in clinical fractures.

*A:* Fracture of the midshaft of the femur in a patient aged five years, two months after injury. The fracture is oblique, and there is evidence of bony union. An area of decreased density persists in the line of fracture.

*B:* Fracture of the femur at approximately the same level as in *A*. This patient is seven years of age, but the bones are atrophic as a result of long immobilization following reduction of a congenitally dislocated hip. Union occurred six weeks after fracture. There is some difference in roentgenographic technique and, while less callus is present, it is impossible to make any accurate comparison between the rate of healing of this fracture and that of the patient in *A*.

*C:* Extensive callus two months after fracture in a patient aged four years. In this instance the fracture is transverse, and there is displacement with some overriding.

It would not be possible to state with any degree of certainty that the rate of healing was any better in one of these cases than in another. The dates between the fracture and the check-up roentgenogram vary, and neither the types of the fractures nor the roentgenographic techniques are identical.

the extremity subjected to the surgical procedure were extremely atrophic, uniformly resulted in osseous union.

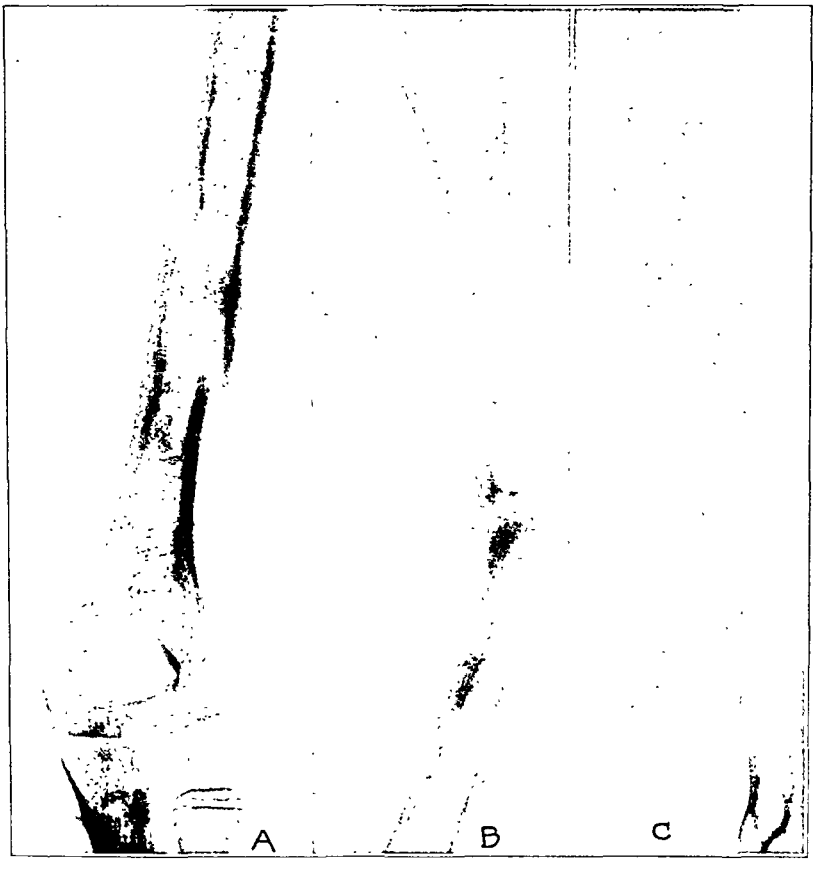



FIG. 2

Fracture of the humerus in three patients, all aged seven years.
*A:* Supposedly normal bone, seventeen days after injury.
*B:* Atrophic bone, four months after fracture, showing non-union. However, a study of interval roentgenograms showed that there had been definite callus and primary union with refracture.
*C:* Complete bony union two months after injury.
No two of these fractures are alike. The atrophic bone in *B* resulted from total paralysis of the arm. Further analysis showed that what appeared to be delayed union was in reality refracture, the primary union not being any stronger than the relative strength of the bone that had been fractured.

## EXPERIMENTAL STUDIES

In our experiments, instead of attempting to produce regional atrophy by paralysis or immobilization, as had been done by other workers, we attempted to bring about generalized wasting of bones both in adult and in young growing rats by markedly reducing the intake of calcium. We then compared the rate and degree of fracture healing in these animals with others on a normal stock diet or on a diet with excessive amounts of cod-liver oil, calcium, or both of these supplements.

carried away from the lesion in the blood stream. One may visualize the spread in certain infections by following the course of the lymphatics in superficial lesions of the soft tissues. If proof is needed that a furuncle is not a local lesion, regular culture of the blood of sufferers will reveal bacteria.[2]

In a class with the furuncle, are to be included skin lesions which are the results of infected cuts, blisters, etc. One frequently sees this very definite picture: a skin lesion that has just healed, with the scab still on the surface, on a patient who has been ill for a day or two with an acute infection which turns out to be osteomyelitis. It is interesting to note that one rarely, if ever, finds a bone lesion present and giving symptoms at the time of an active skin lesion. The "seeding" of the bone lesion takes place during the activity of the skin lesion. If the patient has little resistance to the organism, a fatal septicaemia may terminate the affair before a bone lesion can mature.

The clinical picture seems to show clearly that the organisms commonly get into the blood from a local lesion in the skin, rarely from the respiratory or the gastro-intestinal tracts. Why then, and in what situations do the organisms form a deep lesion? Leaving aside for the time being all questions relating to immunity, and turning to the experimental work, one finds that certain facts relating to the circulation in bone have been established. Teruo Hobo, among others, has demonstrated that inert bodies, such as are found in India ink, when introduced into the circulation of an experimental animal, at once cause the mucous membrane to become dark gray. In ten minutes it is again normal in appearance. If animals treated in this fashion are killed at times varying from three-quarters of an hour to as long as seventeen days, autopsy shows that the spleen, the *bone marrow*, and the liver are stained black, while the lungs, the heart, the kidneys, the brain, the nerve tissues, and the gastro-intestinal tract are clear. Microscopically, the small particles are found in the endothelial cells of the medullary capillaries. In the capillary enlargement of the metaphyses of the long bones the particles are so thickly deposited that it is impossible to recognize the phagocytes. In the lungs and the kidneys there are clumps of organisms. There is a lessened power of phagocytosis, or an absence of it, just at the metaphysis, whereas there is an active process in all the endothelial cells of the medullary capillaries. This work clearly demonstrates what Philip Wilson and others have shown,—namely, that there is a definite anatomical area in the vascular system of the metaphysis which permits marked slowing of the blood stream and a sedimentation in the large venous bay. The arterial capillary leading to this bay is very small and it empties into the large venous pool where the stream is very materially slowed. Combined with the slowing of the stream and its relative stagnation, there is a great scarcity of cellular elements of a phagocytic nature. This is the reverse of what is true in the medulla, as the medulla is extraordinarily rich in blood supply, having large venous channels, and is very plentifully supplied with

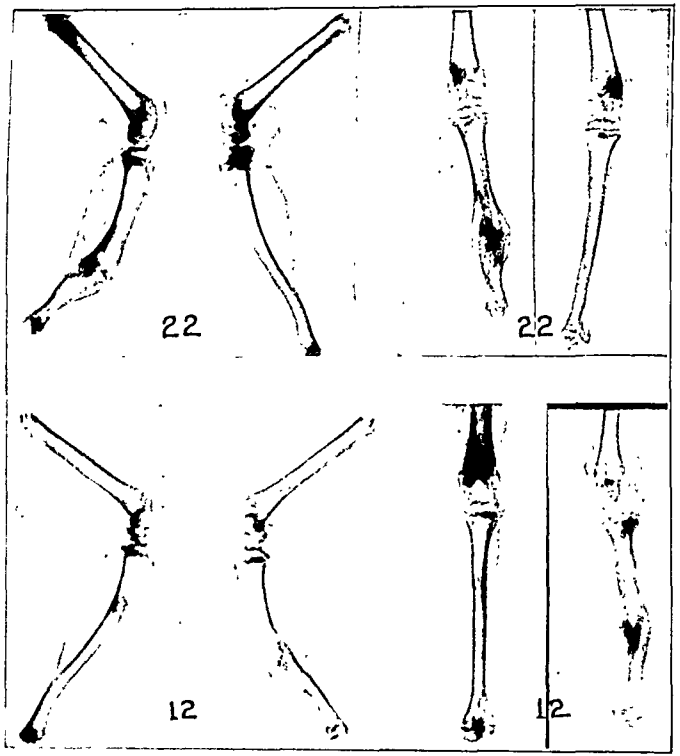



FIG. 3

Rat 22: Group A (2)—low-calcium diet for three weeks before fracture and normal stock diet for four weeks after fracture.

Rat 12: Group A (1)—low-calcium diet for three weeks before and four weeks after fracture.

The cortices of the femora, as well as of the tibiae, of Rat 12 are thinner than those of Rat 22, but there is no demonstrable difference in the healing of the fractures.

FIG. 4

Rat 12: Group A (1)—low-calcium diet for three weeks before and four weeks after fracture. There is thinning of the cortices of all of the bones shown. This is more marked in the extremity in which the fracture was produced than in the normal leg of the same animal.

Rat 32: Group A (3)—low-calcium diet for three weeks before fracture and stock diet with massive doses of calcium and cod-liver oil for four weeks after fracture.

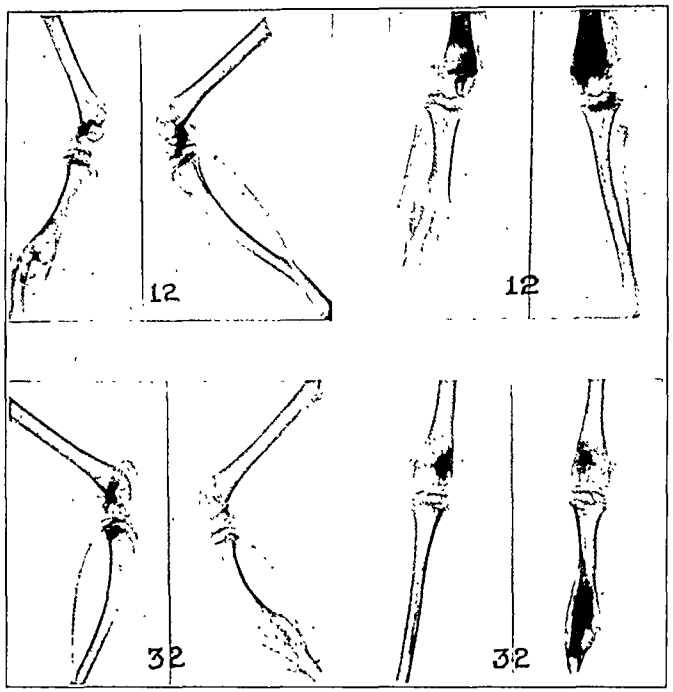



FIG. 4

There is very little difference between the bones of Rat 32 and those of Rat 12 which was on a calcium-deficient diet throughout the experiment. The fractures healed at about the same rate and to about the same extent. The roentgenograms were taken on the same film and printed on the same positive at the same time, so that the apparent demineralization in the bones of Rat 32 cannot be attributed to any difference in roentgenographic technique.

*Experiment I—Healing of Fractures of Tibiae of Growing Rats*

*Procedure*

White rats of the same stock, twenty-one days old, were used and kept on a diet for three weeks. Group A, consisting of sixteen rats, was placed on a low-calcium intake (300 milligrams of phosphorus and from forty to fifty milligrams of calcium per 100 grams of ration):

| | |
|---|---|
| Ground whole yellow corn | 33 per cent. |
| Ground wheat | 33 per cent. |
| Wheat gluten | 16 per cent. |
| Gelatin | 16 per cent. |
| Cod-liver oil | 2 per cent. |

This is a modification of McCollum's diet [19] with cod-liver oil added and calcium left out. Group B included twenty-seven rats which were placed on a stock diet (modification from Bills and Honeywell [3]):

| | |
|---|---|
| Ground whole yellow corn | 52 per cent. |
| Whole-milk powder | 26 per cent. |
| Linseed-oil meal | 12 per cent. |
| Crude casein | 4 per cent. |
| Alfalfa-leaf meal | 1.5 per cent. |
| Brewer's yeast | 1.5 per cent. |
| Sodium chloride | 0.5 per cent. |
| Calcium carbonate | 0.5 per cent. |
| Cod-liver oil | 2 per cent. |

After this period the right tibia of each rat was fractured manually. No splint was applied.

The rats were then divided into sub-groups as follows:

*Group A*—Fed on low-calcium diet for three weeks before fracture.

After fracture:

(1) 6 remained on a low-calcium diet.
(2) 5 changed to stock diet.
(3) 5 changed to stock diet plus 12 per cent. calcium and 8 per cent. cod-liver oil.

*Group B*—Fed on stock diet before fracture.

After fracture:

(1) 5 changed to low-calcium diet.
(2) 6 remained on stock diet.
(3) 6 remained on stock diet with added 8 per cent. cod-liver oil.
(4) 6 remained on stock diet with 12 per cent. calcium.
(5) 4 remained on stock diet with added 8 per cent. cod-liver oil and 12 per cent. calcium.

Roentgenograms were taken at the time of fracture and each week thereafter. One-half of the animals were sacrificed twenty-one days and the remaining rats twenty-eight days after fracture. The bones of the hind legs were removed, x-rayed, fixed, imbedded in celloidin, and sectioned.

*Results of Experiment I*

The rats on all diets gained weight and grew equally well, and in no

As estimated from studies of the roentgenograms, the rate of union was approximately the same in all groups, but the quality of union and of the bones themselves was best in the groups receiving normal stock diets throughout the experiment, and this was not definitely altered by the supplement of cod-liver oil or of a combination of calcium and cod-liver oil.

The rats receiving an excess of calcium added to the normal stock diet, Group B (4), or an excess of cod-liver oil and calcium added at the time of fracture to the previous low-calcium diet, Group A (3), showed in the roentgenograms of the specimens four weeks after fracture approximately the same relative degree of loss of bone density and at least no better quality of fracture healing than was present in the group that was constantly on the low-calcium diet, Group A (1), or that changed to this diet at the time of fracture, Group B (1).

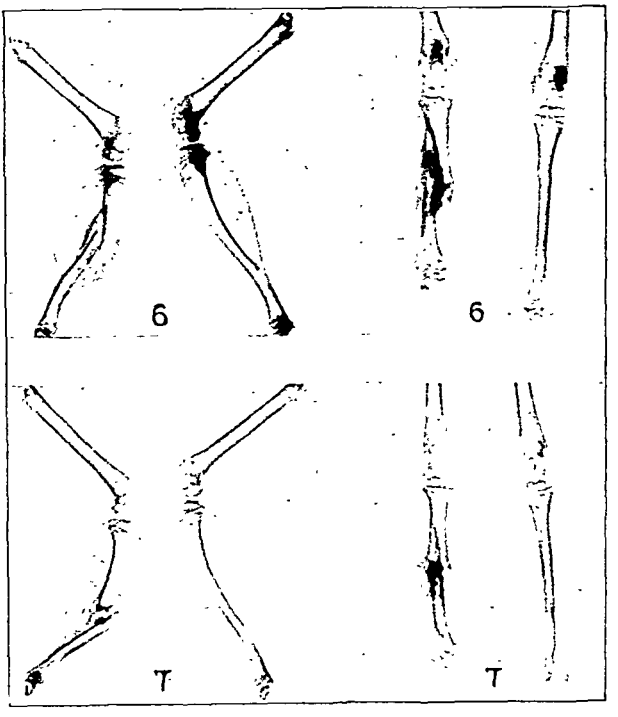



FIG. 6

Rat 6: Group B (3)—normal stock diet before fracture and high cod-liver-oil supplement for three weeks after fracture.

Rat 7: Group B (4)—normal stock diet before fracture and high-calcium supplement for three weeks after fracture.

There is no definite atrophy or difference between the bones of the rats in these two groups. The cortices of the femur and the tibia of the fractured extremity of the rat receiving the high-calcium diet (Rat 7) are not as well developed as those of the rat receiving the high cod-liver-oil supplement (Rat 6), but the difference is slight. There is approximately the same degree of displacement between the fracture fragments. Union of the fractures in the group receiving the cod-liver-oil supplement was better than that for the group receiving the excess amount of calcium. Roentgenograms of Rat 7, Group B (4), showed a continued zone of decreased density across the callus.

In *all* specimens, at the end of twenty-one days, microscopic sections showed ossification of the outer thirds of the external callus with some penetration of the bone marrow into and around the peripheral trabeculae. A new bony cortex was beginning to consolidate, but transversely between the ends of the fragments there was a fairly heavy strand of fibrous tissue which merged on either side with cartilage cells of the callus.

Microscopic sections of the specimens from the twenty-eight-day series showed greater differences in the degree of bone union at the sites

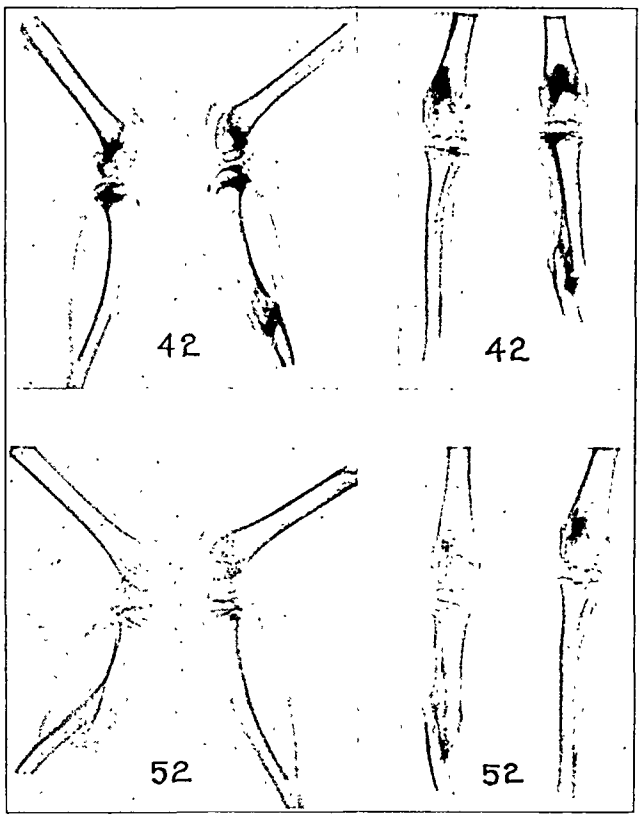



FIG. 5

Rat 42: Group B (1)—normal stock diet for three weeks before fracture and calcium-deficient diet for four weeks after fracture.

Rat 52: Group B (2)—normal stock diet three weeks before and four weeks after fracture.

The diameters of the bones of Rat 42 are less than those of Rat 52, and the cortices are thinner. There is about the same degree of displacement of the fracture fragments, and, while the total size of the ossified callus of Rat 52 is larger than that of Rat 42, the quality or degree of union of the fractures in the two rats is quite similar. The roentgenograms were made on the same film, at the same exposure, and were printed on the same positive, so that a comparison between the two is justified.

instance did rickets develop. All began to use their fractured legs for walking between the second and third weeks. Roentgenograms showed a moderate but definite bone atrophy, evidenced by relative thinning of the bone cortex and decrease in diameter of the shaft of the bones of animals on the low-calcium diet, Group A (1), as compared with the controls, Group B (2). Although attempts were made to keep the roentgenographic technique identical throughout the experiment, we were unable to form any definite opinions regarding relative degrees of healing from roentgenograms of the living animals. A few of the roentgenograms taken seven days after fracture showed faint callus shadows. On the fourteenth day, callus was demonstrated for all of the fractures, but a wide clear zone extended transversely across the callus between the bone ends. On the twenty-first day the callus was uniformly larger and more dense. However, the size of the callus seemed to conform more to the amount of angulation and overriding than to the amount of calcium or cod-liver oil in the diet. The uncalcified clear zone, which ran somewhat transversely across the callus and subsequently in microscopic sections was shown to be a zone of fibrous or osteoid tissue, was now much thinner. On the twenty-eighth day, in only a few of the specimens x-rayed could these transverse clear zones in the callus be seen. Most of the callus now showed bony trabeculae joining the fragments, but the medullary canals had not been reestablished. Roentgenograms of the cleaned long bones of the rats of Groups A (3), B (1), and B (4), taken on the same film at the same time and printed upon the same positive as bones from other groups, showed relatively thinner cortices and smaller diameters. (See Figures 3, 4, 5, 6, and 7.)



FIG. 8-B

Photomicrograph (×87) of a rat from Group A (1)—calcium-deficient diet for three weeks before fracture and for four weeks after fracture. Atrophic bone trabeculae extend completely across the site of the fracture. The trabeculae are widely spaced, with large areas of fatty marrow and fibrous callus in which are spaces filled with blood.



FIG. 8-C

Photomicrograph (×87) of a rat from Group B (2)—normal stock diet throughout. The animal was sacrificed four weeks after fracture. The degree of healing is definitely more advanced than in either Fig. 8-A or Fig. 8-B. The trabeculae of new bone are thicker. The marrow-filled spaces are smaller, and there is relatively little fibrous callus still present.

infiltrated the periosteal and endosteal callus. In a few instances the marrow cavities of the two fragments seemed to be continuous, but in most of them there were intervening trabeculae, and in many sections either a small band of fibrous tissue broke the continuity of the periosteal new bone or extended transversely across the mid-portion of the callus, or islands of cartilage were present and extended transversely in the endosteal callus. A detailed comparative analysis of the changes noted in the typical microscopic sections accompanies Figures 8-A through 9-B.

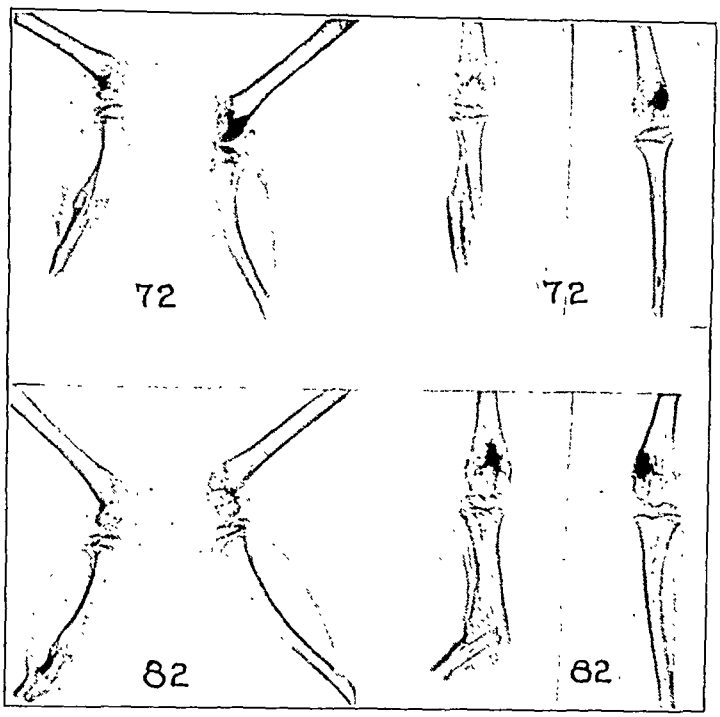



FIG. 7

FIG. 7

Rat 72: Group B (4)—normal stock diet before fracture and excess calcium as a supplement for four weeks after fracture.

Rat 82: Group B (5)—normal stock diet before fracture and high-calcium and high cod-liver-oil supplement for four weeks after fracture.

Comparison of the roentgenograms of the two rats shows a relative decrease in density of the bones of the rat receiving the high-calcium supplement (Rat 72), with less complete bony union of the fractures. The rat receiving supplements of both cod-liver oil and calcium (Rat 82) developed bones quite comparable to those of the normal control Rat 52 (Fig. 5).

of the fractures. (See Figures 8-A through 9-B.) In each specimen there was a well-formed new bone cortex, and the old cortex, which extended into the callus, was undergoing absorption. New bone trabeculae, many of them large and dense,




FIG. 8-A

Photomicrograph (×87) of a rat from Group A (3)—calcium-deficient diet before fracture and stock diet with high cod-liver-oil and high-calcium supplement for four weeks after fracture. A section taken through the callus at the exact level of the fracture shows bone trabeculae which are widely spaced, with a zone of dense fibrous tissue which represents the transverse shadow of decreased density in the roentgenogram previously described. The degree of ossification, as illustrated in this photomicrograph, is less than that in the rats of other groups, although this rat received a maximum of the supplement in the form of massive doses of calcium and cod-liver oil after fracture.

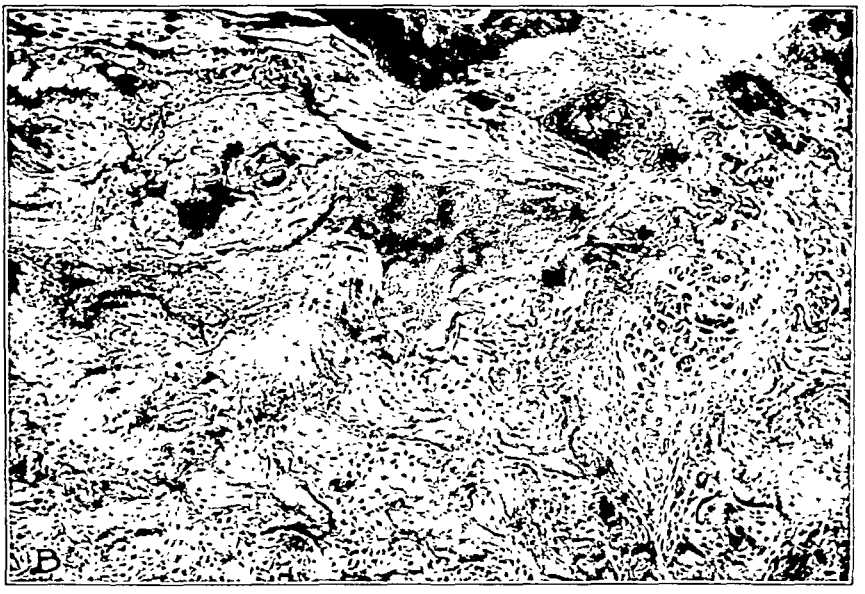



FIG. 9-B

Photomicrograph (×87) of a rat from Group B (3)—normal stock diet before fracture and high cod-liver oil supplement for four weeks after fracture. This photomicrograph shows more complete healing, as evidenced by larger bone trabeculae, fewer areas of fibrous or cartilaginous callus, and smaller areas of fat-filled marrow, as compared with the bones of the rat receiving the same diet plus calcium instead of cod-liver oil in the supplement (Fig. 9-A).

osteoporosis to be demonstrated in the roentgenograms. The addition of ammonium nitrate to the diet of one sub-group after fracture did not produce a condition of definite bone atrophy in the unfractured tibiae. Healing was shown, roentgenographically and microscopically, to progress well in all rats. A thin, transverse clear zone in the callus shadow was still present roentgenographically, and a corresponding zone of fibrous and osteoid tissue was demonstrated microscopically in each of the fractured tibiae obtained at necropsy forty-five days after fracture.

The adult rats were much less susceptible to a decreased calcium intake as far as bone density and fracture healing were concerned than were the growing animals. The addition of an acidifying agent in moderate amounts did not produce demonstrable bone atrophy or influence fracture healing in this experiment.

## DISCUSSION

We were able to confirm the observation of Clarke, Bassin, and Smith that it is possible to produce atrophy of the bones of young growing rats by feeding a diet which is deficient in calcium, without the development of rickets. The changes in the skeleton caused by diets deficient in minerals are quite similar (although generalized) to the local atrophy of bone resulting from disuse, produced experimentally by Allison and Brooks.

Lachmann and Whelan have shown that before atrophy can be

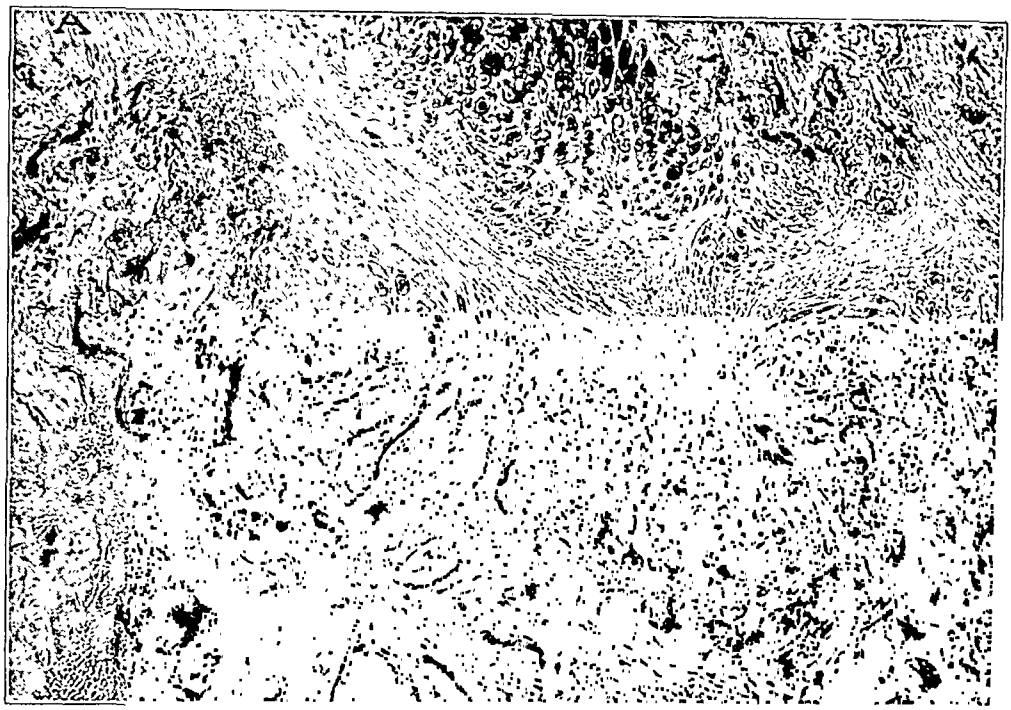



FIG. 9-A

Photomicrograph (×87) of a rat from Group B (4)—normal stock diet before fracture and excess calcium added to diet for four weeks after fracture. There is extensive replacement of the fibrous callus with thick bone trabeculae, but the zone of unossified fibrous tissue still extends completely across at the fracture site. On either side of this zone there is an area of unossified cartilaginous callus. Although this rat was not at any time on a deficient diet and received excess of calcium after fracture, the degree of healing, as evidenced both in the roentgenograms and in the photomicrograph sections, was less complete than in the rats receiving supplements of cod-liver oil, or calcium-deficient or normal stock diets without any supplement.

The quality of the union was comparable to the quality of the fractured bones.

*Experiment II—Healing of Fractures in Adult Rats*

*Procedure*

Twenty adult rats of average weight and size were divided into two groups of ten each. One group was fed the normal stock diet and the other was placed on the low-calcium ration used in Experiment I for four weeks. The right tibia of each of the rats was then fractured. The first group was allowed to remain on the stock diet. The low-calcium group was subdivided,—half remained on the same ration and the rest (five rats) were fed the low-calcium diet with added 3 per cent. ammonium nitrate for the purpose of increasing calcium excretion. Roentgenograms were taken three, ten, seventeen, twenty-four, thirty-one, and forty-five days after fracture. On each of the last three occasions, one-third of the animals in each group were sacrificed, and the fractured tibiae, together with the normal tibiae, were x-rayed on the same roentgenogram. Each fractured specimen was then fixed in celloidin and sectioned.

The low-calcium diet before fracture did not produce sufficient

large numbers of cellular elements of the highest order. Wyssokowitsch has made interesting observations upon the fate of living organisms injected intravenously into experimental animals. He has demonstrated that the blood culture of a rabbit which has been given a lethal dose of anthrax organisms shows: after five minutes, fifteen colonies; in two and one-half hours, no colonies; in forty-six and one-half hours, three colonies; in seventy-two hours, fifty-six colonies; and in eighty-four hours, countless colonies, followed by death. Likewise, in other animals having a similar dose no colonies are found at the end of twenty-four hours, yet at autopsy at this time forty-five colonies have been obtained from cultures from the liver and the spleen. Lexer showed also that organisms introduced into animals create abscesses in the viscera, the muscles, and the bone. Some experimental work done by the author in an endeavor to produce osteomyelitis, using staphylococcus as the infecting organism, demonstrated that if one wishes to engender osteomyelitis a young animal should be used. The introduction of organisms into adult animals caused septicaemia and in some cases arthritis, but osteomyelitis could not be produced. If an animal in its cartilage age was used, there was no difficulty in causing bone lesions in association with lesions of a septic nature elsewhere in the body. In the bone these lesions were found to be located in three places: in the metaphysis, in the medulla of the epiphysis, and beneath the periosteum. The experimental work, therefore, seems to indicate that the local lesion in the bone is most frequently found in the metaphysis, and is due to a combination of slowing of the blood stream and lack of phagocytic elements in the metaphysis. It has been shown that organisms ingested by a phagocyte are not necessarily dead. It is possible, therefore, for organisms to survive over long periods of time in such a location. Moreover, in the microscopic sections taken from animals with experimentally produced osteomyelitis one can find organisms in the cartilage cells of the epiphyseal line, and it is possible for these to remain a very long time in this location under suitable conditions.

If, therefore, a metaphysis is "seeded" from a skin lesion, although the skin lesion heals, the newly formed lesion in the bone develops activity; then it, in turn, soils the blood stream and "seeds" other areas of predilection, so that the result is a continued septicaemia which may produce other local lesions. Lexer found that by using an organism of low virulence he could produce in bone a disease of low activity in that the importance of the infection depended upon the virulence of the organism.

*Trauma* is well recognized as an agent for devitalizing tissue, and devitalized tissue is very fertile soil for the growth of organisms. Hemorrhagic areas and substances are ideal for the growth of bacteria. Any tissue that has a poor blood supply is very weak in resisting infection. Trauma in an animal which is suffering from septicaemia is likely to produce a local lesion at the site. There are specimens demonstrating this in various laboratories throughout the world. There is one in particular in the Museum of the Royal College of Surgeons, in England,—a bone taken

demonstrated by the roentgenogram, in the neighborhood of 20 per cent. of the mineral element of the bone must be lost. Therefore, the roentgenogram is not a satisfactory method of determining slight changes in the mineral content of the bone. We were not successful in producing enough atrophy in the bones of adult rats in the time allowed for the experiment to enable us to make any definite statement from the roentgenographic comparisons. Jaffe, Bodansky, and Chandler reported that ammonium chloride added to a low-calcium diet produced marked osteoporosis and a picture quite similar to osteitis fibrosa if the decalcification was rapid. They further stated that calcium intake did modify the effect of ammonium chloride on the bone. In our experiments the addition of ammonium nitrate to the low-calcium diet of adult rats failed to produce demonstrable atrophy. All fractures in adult rats in all of the groups appeared to heal equally well. Definite roentgenographic, as well as microscopic, evidence of bone atrophy was obtained in the growing rats fed on a low-mineral diet.

In the study [5] which we had previously made, it was shown that fractures of rachitic bone did not heal as rapidly or as well as fractures of normal bone in animals of the same series. Fractures of non-rachitic atrophic bone, both in clinical cases and in the experimental animal, united as rapidly as did fractures in the normal controls. From these observations we may conclude that mesodermal tissue cells proliferate as well in the repair of a thin bone matrix as in that of a bone matrix of normal density, and perhaps sometimes more easily in the former. The speed of healing of atrophic bone, then, is at least not decreased, but the total amount of callus is on the average less than in bone in which there are more normal supplies of mineral salts and hence the union, as reported by Lindsay, is only as strong relatively as the strength of the shaft of the bone which has been fractured. We found that fractures of bones in either young or old rats on mineral-deficient diets did not heal more promptly or more adequately when large amounts of vitamin D or of calcium, or of both substances, were added to the diets than did those in rats which had been on a normal basic diet previous to fracture; in some instances, these supplements seemed to retard bone repair. The only two rats in our series which showed delayed union were in this group. We observed also that atrophy of the *fractured bone,* both in the low-calcium group and in the group of rats on the stock diet, was consistently more marked than in the unfractured extremity of the same animals. This may be explained by the fact that for a period of about two weeks after fracture the limb was not used normally.

Grauer reported the observation that massive doses of vitamin D not only did not improve fracture healing, but they seemed to delay union. Jones and Robson, in carefully planned and executed experiments, were able to demonstrate that irradiated ergosterol in toxic doses produced marked degenerative changes in growing bones of rats. Microscopic studies of these bones showed that the atrophy resulted from the removal

of the organic, as well as of the inorganic, matrix. There was definite osteoplastic activity, and the bones were soft and fragile. When these rats were fed low-calcium diets, together with the high-ergosterol intake, the picture was approximately the same.

Our studies would seem to indicate that there is a *threshold of mineral and vitamin normalcy* below which bones become atrophic. If the vitamin-D deficiency is marked, rickets also develops and fractures of the rachitic bones heal very poorly. If the deficiency is largely of the mineral element, bones may become atrophic with no rachitic changes without affecting the rate of fracture healing, and the quality of union will be comparable to the quality of the bone fractured.

## SUMMARY

1. Atrophy of bones of young rats was produced by feeding a diet low in calcium content.

2. The healing of fractures of atrophic bones produced by a diet low in calcium progressed to the stage of complete bony union at a rate comparable to that observed in animals of a control series fed a normal stock diet.

3. The total amount of bone laid down in repair was less and the new trabeculae and cortices of the bone were definitely thinner in those animals fed the deficient diet than in those constantly receiving a diet adequate in calcium.

4. Addition of an excess of vitamin D or calcium carbonate, or both of these elements, to the diet of rats, whether they had been previously on a diet low in calcium or on a normal stock diet, did not hasten the rate or improve the quality of healing of the fracture, as compared with the fracture healing of rats constantly fed the normal stock diet.

5. Some evidence is presented to indicate that massive doses of calcium or of calcium and vitamin D by mouth may produce an inhibiting effect on the quality of healing of fractures of normal or atrophic bones.

6. Since the vitamin-D requirement for the average human adult is not known, and since massive doses of vitamin D may produce atrophic changes in the bones of experimental animals and delayed healing of fractures, we question the advisability of continuing the practice now becoming common of prescribing massive doses of vitamin D, or of vitamin D and calcium, for patients with fractures, in whom there is no evidence of a deficiency of these elements.

7. There is a real need of a carefully planned and executed long-time study to determine the vitamin-D and calcium requirements of the average adult human.

## CONCLUSIONS

A study of the importance of vitamin-D supplements in the healing of fractures either of atrophic or of normal bones was not the original or primary reason for undertaking the experimental work which we have de-

scribed. As we began to analyze our results it became obvious that they would support the conclusions of other laboratory workers who had reported degenerative changes in the bones following prolonged administration of large doses of vitamin D.

Within the past few years there has been a growing tendency on the part of clinicians to prescribe enormous doses of vitamin D in the form of purified concentrates. The dangers of hypervitaminosis D have been either unrecognized or ignored. Doses as high as 500,000 international units have been used and recommended in the treatment of arthritis, and the addition of supplements of vitamin D, or of calcium, or of both of these substances, to the well-balanced normal diet of patients who have sustained fractures of apparently normal bones has become common practice. Patients frequently demand to know why we do not recommend these supplements because their friends or acquaintances have taken them upon advice of their physicians.

Studies referred to in this paper indicate that lack of vitamin D to the extent of the production of rickets may be a factor in causing delayed union or non-union. There is *no good evidence* that the addition of vitamin D or of calcium to the average stock diet of experimental animals or to the well-balanced diet of patients has *any beneficial effect in the healing of fractures.* The results of experiments reported in this paper and those from other laboratories indicate that large doses of these supplements may cause delay in the healing of fractures and wasting of the bone substance, as demonstrated in roentgenograms and in photomicrographic sections. Recent observations in a few clinical cases have added to the evidence obtained in work with experimental animals that delayed healing of fractures in some patients may be the result of hypervitaminosis D and not, as is so commonly assumed, of a deficiency of this substance in the diet.

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# AN ARTHROPLASTIC PROCEDURE FOR CONGENITAL DISLOCATION IN CHILDREN *

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Any operative procedure advocated for congenital dislocation of the hip must have proved its effectiveness over a period of years, and any evaluation should be based both upon the functional result and upon the postoperative changes noted roentgenographically.

Everyone interested in this problem recognizes that there is an age limit under which actual reduction and functional cure can be accomplished, and an age limit beyond which actual reduction is impossible or, if possible, fraught with so many dangers that it is not desirable.

Galloway [3] has long advocated open operations on very young children, but we feel that under the age of three closed reduction is still the method of choice. In a recent end-result study [5] of congenital dislocation of the hip in children under three, treated by closed reduction and manual correction of the anterior distortion, functional and anatomical cures were reported in 75 per cent. of the unilateral cases and in 65 per cent. of the bilateral cases. We think that this is a higher percentage than is usually obtained, and we attribute it to the recognition and correction of the anterior distortion by manual osteoclasis[4], feeling that open operation in children under three should be reserved only for those cases in which a closed reduction has failed. We believe that the procedure advocated is particularly applicable to the young patient in whom reduction cannot be maintained by the closed method.

We have tried to define an age limit for the procedure advocated, and would say that the best results have been obtained in children under the age of eight. We feel at this time that the upper limit for the procedure in the unilateral case should be ten, while in the bilateral case the best results are obtained in children under six or seven years of age.

Many procedures have been advocated to correct the increasing instability in growing children, but few open operations have achieved free mobility with a true reduction of the upward and backward dislocation of the head of the femur. The purpose of the arthroplastic type of acetabular reconstruction presented here is to obtain actual reduction of the dislocation, restoration of stability to the hip joint, and preservation of a satisfactory range of movement.

The congenital maldevelopment of the acetabulum is generally accepted as the underlying cause of the occurrence of the dislocation, but

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varying secondary changes that soon take place in the upper extremity of the femur and in the surrounding soft tissues all have to be reckoned with in considering these unstable and shortened limbs. There are two very important factors upon which the prognosis is largely based,—the age of the patient, which has already been mentioned; and the laxity of the tissues about the joint, evidenced by the telescoping manoeuver. Laxity of the soft tissues is a variable quantity, and, although not wholly dependent upon age, it is largely so. The degree of soft-tissue relaxation can be easily determined before beginning treatment by taking two roentgenograms, one with and the other without manual traction. The question of anterior distortion in the cases that have come to open operation, has not, in our hands, proved to be such a problem as in cases treated by closed methods of reduction, for in only a few instances have we found it necessary to do a supracondylar osteotomy. We feel that this is probably because we are able to reconstruct the acetabulum at the time of the second stage, and this allows the stability of the reduced head of the femur to depend, not upon the anatomical shape of the maldeveloped acetabulum, but upon the depth and slope of the reconstructed socket made at open operation.

The capsule-covered head of the femur is almost always displaced, not only upward, but backward, and, if the type of operation chosen does not succeed in bringing the head both downward and forward, the lordosis and characteristic limp will be improved very little. In addition to these changes, the abductor group of muscles, as well as the adductors, the hamstrings, and the rectus femoris portion of the quadriceps, are shortened and contracted, making a preliminary period of effective traction necessary before any open operation is advisable.

### FIRST STAGE

We have found that, within the age limits mentioned, we can usually pull the femoral head down, so that it is approximately opposite the original site of the acetabulum. This has been done in a variety of ways. In the younger patient, it is necessary only to apply moleskin to the affected limb twenty-four hours previous to a thorough stretching and subcutaneous tenotomy. This permits the moleskin to be well attached to the skin before traction is instituted. In other cases, we have used skeletal traction on the lower end of the femur. In a few of the older patients, a curved incision has been made along the crest of the ilium and a subperiosteal stripping of the gluteal muscles has been done, which is particularly to be recommended in the older and more resistant cases.

Various methods have also been utilized to immobilize the pelvis and to obtain effective downward traction on the limb. The most satisfactory method in our hands has been the application of a well-padded long plaster spica to the opposite side and traction of from fifteen to twenty-five pounds over a period of time sufficient to relax the contracted tissues thoroughly and to bring the head of the femur opposite the site of the original

acetabulum. This first stage in the procedure may require two or three weeks, or even longer, but it is very important to delay the second stage until the maximum relaxation has been obtained and the position of the head proved by roentgenograms.

### SECOND STAGE

In some instances, the Smith-Petersen approach has been used, but the following procedure has been more frequently employed. A skin incision is made, beginning about two inches behind the anterior superior spine, curving forward, downward, and then backward to a point on the thigh about two inches below the tip of the greater trochanter. The origin of the rectus femoris tendon at the anterior inferior spine is identified and examined. If it seems contracted, it is divided by a zigzag tenotomy. The fascia on the lateral aspect of the thigh is then cut transversely, and a portion of the tip of the greater trochanter with the attached gluteal muscles is identified, chiseled through, and turned upward. The elongated portion of the capsule of the hip joint covering the head of the femur is easily identified and completely separated from the surrounding structures by careful dissection with scissors. When the isthmus of the capsule is reached, it is divided; the head of the bone is inspected, and the shape and the presence or absence of the ligamentum teres are noted. Many of the cases have shown the acorn-shaped type of head, with smooth, glistening normal-appearing cartilage and not a trace of the ligamentum teres; in some instances only a short, flat, ribbonlike structure remained. In the younger patient there has often been noted an elongated and well-developed ligamentum teres, and a division of this structure has apparently caused no later disturbance in the development of the head of the femur. After the appearance of the femoral head has been noted, the opening in the capsule is closed with several chromic sutures. With Doyen reamers, or preferably with a large curette, a capacious acetabulum is formed as near its original site as preliminary traction has made possible. The site of the acetabulum is further checked by identifying the triradiate cartilage in its floor. After this has been done, the capsule-covered head is gently pulled down and placed *without force* in the deepened and reamed-out acetabulum; the abductor muscles with the attached cartilage from the greater trochanter are sutured back into place. The wound is then closed in layers, and a long plaster spica is applied. This plaster is retained for four weeks, but two weeks after the second-stage operation the posterior portion of the cast covering the foot and leg is removed, and active movement of the knee is accomplished whenever the patient is lying on the abdomen. At the time when the patient is turned over, the posterior shell is strapped back into place and supports the leg and foot. Four weeks after operation, the entire plaster is removed, and the limb is suspended in a posterior splint. At this time, active and passive motions are started and the patient is encouraged to use the abductor, the flexor, and the extensor muscles during a portion of each day. No weight-bearing is

advised for three months after operation; if desired, the patient can then be fitted with a Thomas walking splint, although this has rarely been done.

This method was originally described in 1932 [1] and has been employed practically unchanged ever since.

## DISCUSSION

The following statement from a previous article [2] on this subject, published in 1936, is still applicable: "While the time of follow-up with the procedure advocated is insufficient to draw any definite conclusions as to what will be the ultimate functional and roentgenographic appearance of these hips, certain observations have been noted in the patients operated upon. The hips have all remained reduced and stable with a varying degree of movement. . . . By cutting through the greater trochanter a stimulation of its growth has been observed, and this in the later cases appears to have been lessened by carefully removing only a small portion of the cartilage when the abductor muscles are reflected upward during the second stage. A surgical fusion of this epiphysis at this stage might obviate this, but it has not been considered necessary to date. An increased density of the roof of the reamed-out acetabulum has been a frequent finding and we must assume that the transplanted capsule about the head becomes attached to the newly formed acetabulum, allowing the head to move easily within it. The depth of the reamed-out acetabulum appeared either unchanged or in some instances even appeared to have become deepened after several years of weight bearing."

The complications met with in this operation depend upon two general factors. The first is failure to recognize the age limit of the operation. The fact seems to be true that in the adolescent child the structures about the dislocated hip are unable to lend themselves to the accommodative changes necessary to produce a satisfactory range of movement. The loss of mobility in the unilateral reconstructed hip is not a particularly serious complication, but we feel that it should be avoided if possible, and in this older age group we prefer some type of osteoplastic buttress. The second factor determining a satisfactory functional hip is dependent upon the degree of trauma produced in reducing the head into the reconstructed acetabulum. If the stretching of the tissues in the first stage has not been effectively accomplished, the capsule-covered head cannot be easily and gently placed into its new site, at the second stage. Vigorous manipulation or replacement of the head under tension, as with the aid of a skid, will give an opportunity for pressure necrosis, not only of the capsule over the head, but even of the head itself.

We have had no deaths following the procedure, and, since doing the first operation in 1930, we have attempted, by the trial and error method, to determine the limitations of the procedure.

Only a long period of time can conclusively prove the value of any method for treating congenital dislocation of the hip, but we now feel that within the age limits mentioned, and following the method outlined,

one will obtain a most satisfactory result functionally and roentgenographically.

The method is, therefore, presented for consideration; its limitations are stressed; and it is hoped that it may be tried by other orthopaedic surgeons and properly evaluated.

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# RECURRENT DEFORMITIES IN STABILIZED PARALYTIC FEET

## A Report of 1100 Consecutive Stabilizations in Poliomyelitis

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Stabilization of feet totally or partially paralyzed has long been recognized as a valuable adjunct to the therapeutic measures available for patients with residual poliomyelitis. The type of stabilization has varied from simple arthrodesis of the talocalcanean joint to the more extensive procedures in which several joints of the foot are fused. Stabilization alone was originally thought to be sufficient to ensure a permanent satisfactory weight-bearing foot, irrespective of the type of foot present, the deformities in the remainder of the extremity, or the status of the individual muscles about the foot and ankle. Subsequent findings, however, have proved that these other seemingly extraneous factors have to be considered if a permanent satisfactory result is to be obtained.

Since the St. Louis unit of the Shriners' Hospitals for Crippled Children was opened in 1924, 1100 feet have been arthrodesed for the correction of deformities associated with residual poliomyelitis alone. In the majority of these feet, the ordinary triple arthrodesis was used.—namely, arthrodesis of the talocalcanean, talonavicular, and calcaneocuboid joints. In some, the calcaneocuboid joint was not fused, and in a few of the earlier ones, only the talocalcanean joint was done. This entire group of feet were operated upon by or under the direct supervision of only eight men, all of whom were adequately trained. This ensured a well-controlled series and should serve to prove that inadequate operation was a negligible factor in the recurrence of deformities. In spite of this fact, 212 recurrent deformities have been encountered in this series of 1100 feet. This represents approximately 20 per cent. of recurrences, and is far higher than was expected at the time this study was begun. The evaluation of the end result in each case was made by personal observation of one or of both authors and not by a simple *résumé of notes left by other* individuals. One might at first assume, as we did, that most of the recurrences took place several years ago before the field of reconstructive surgery had been developed to its present-day status. However, we were surprised to find that one-third of these deformities had occurred during the last five years. In other words, these deformities are still occurring in spite of our attempts to give each patient a well-balanced foot and a correctly aligned extremity from a mechanical standpoint.

Many of these recurrent deformities have been mild, but *every variation from what should be considered a perfectly satisfactory end result has been included.* In our opinion, only seventy-four of these recurrences (7 per cent. of the total number of cases) were severe enough to justify additional surgical procedures. The deformity was corrected at a second operation in seventy cases and in the remaining four restabilization was advised but refused.

Follow-up examinations have been carried out in the majority of these cases over a period of several years. It has been found that approximately one year is required for a recurrent deformity to become well developed, and any case followed for a shorter period of time cannot be classed as a permanent satisfactory end result. In this series, there were ninety-seven feet in which no follow-up examination was possible, or the cases were followed for less than a year. These might have eventually presented evidence of recurrences. Had complete follow-up been possible in every case, our percentage of recurrences might be still higher.

An attempt has been made to analyze each case and to establish as nearly as possible the exact reasons for the recurrence. The etiological factors can be listed, and will be discussed as follows:

1. Abnormal muscle pull;
2. Associated deformities in remainder of extremity;
3. Patient too young when stabilization was done;
4. No demonstrable cause for recurrence.

One or more of these etiological factors may be present in the development of the recurrence. For instance, there were fifty feet showing not only an abnormal muscle pull, but also associated tibial torsion or knock-knee. Some form of abnormal muscle pull is obviously the most frequent and most important of the various factors, and recurrent deformities have only been attributed to factors other than this when it has been impossible to explain them on the basis of muscle imbalance.

### ABNORMAL MUSCLE PULL

Stabilization of any foot abolishes the motion only in the intertarsal joints which are fused, leaving intact the motion in the remainder of the foot. In the usual triple arthrodesis, the hind foot is thus made stable, but a deformity is still possible in the fore foot unless the muscle power on the two sides of the ankle joint is in perfect balance. Arthrodesis of the ankle will not abolish this tendency, as the deformity takes place in the fore foot.

In our series, some form of abnormal muscle pull definitely accounted for 155, or 73 per cent. of the recurrent deformities. Strong peroneal muscles were responsible for eighty-eight of these. This recurrence is the result of normal or strong peroneals in opposition to weak or paralyzed anterior and posterior tibials. Some occurred in earlier cases where the peroneus longus tendon alone was transplanted forward into the dorsum of the foot to replace a *paralyzed tibialis anterior.* In these, the peroneus

brevis left behind was often strong enough to pull the fore foot out of line. In other feet, this type of deformity has occurred where the peroneals were left intact, as it was believed that they were adequately balanced by the power of the anterior and posterior tibials. This type of recurrence presents a very characteristic picture. (See Figure 1.) The stable hind foot remains in good position, with the heel in proper alignment with the ankle joint. The fore foot, however, is pulled into a valgus position and in addition is definitely everted. Both the peroneus longus and the peroneus brevis serve as factors in this valgus tendency, while the peroneus longus produces the eversion. This is made possible by its pulley effect in the groove on the inferior surface of the cuboid and its path across the plantar surface of the foot to insert into the first cuneiform and base of the first metatarsal. In the development of this deformity, the anterior and posterior tibials must be weaker than the peroneal group. In the normal, well-balanced foot, the tibialis anterior and the peroneus longus counterbalance each other in their actions. The tibialis anterior inserts on the dorsum of the longitudinal arch and tends to elevate it and to invert the foot, while the peroneus longus inserts on the plantar surface and tends to depress the arch and to evert the foot. Their directly opposite actions help to maintain satisfactory balance and correct architectural structure in the normal foot. Therefore, the loss of the lifting effect of the tibialis anterior on the inner border of the foot is an additional factor in the eversion deformity. Associated with this, the inner border of the foot is flatter than normal, although this is largely controlled by the stabilization. A few feet have been seen in which normal extensor muscles to the outer toes also aided in this deformity.

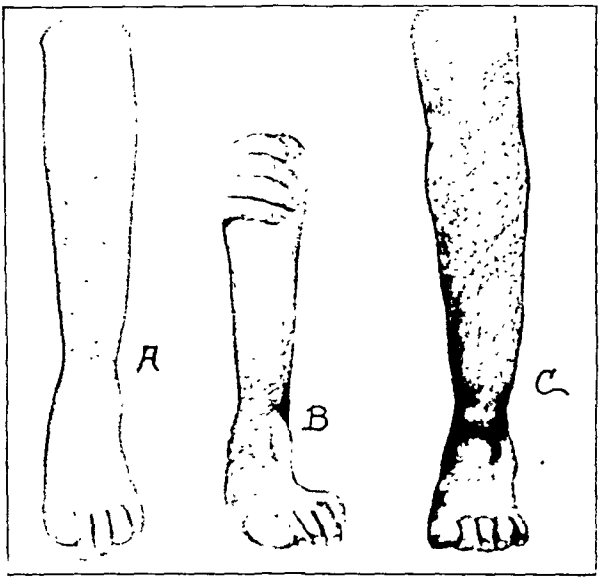



FIG. 1

A typical recurrent deformity resulting from an unopposed peroneal group left intact following the original stabilization.

*A:* The foot is in good position following the triple arthrodesis.

*B:* The same foot six years later. Note that the hind foot remains in correct relationship to the ankle joint, while the fore foot has been pulled laterally as a result of the abnormal pull.

*C:* The correct alignment has been restored after reconstruction of the fore foot and transplantation of the tendons of the peronei into the calcaneum.

The pull of a

from a child who was killed in an accident, in which the epiphysis was injured just sufficiently to produce a hemorrhage in it. This would be an ideal place for the location of organisms floating in the blood.

### HUMAN PATHOLOGY

The pathological picture presented in a human being is that of an infection of the end of the diaphysis,—that is, of the metaphysis. It occurs only in children and before the epiphyseal line disappears. Periostitis and epiphysitis occur. Epiphysitis is due to infection of the medulla of the epiphysis, and in infants is probably the source of the arthritis that one finds so common. The organisms lodging in the metaphysis produce the exotoxin which has the property of causing necrosis. In this way their local field is very much wider and the local abscess grows quickly and viciously. The exotoxin is highly poisonous, and its circulation in the blood causes general symptoms which are important. With the occurrence of infection in the region of the metaphysis and of the periosteum, pus is formed and the periosteum is stripped up. This stripping of the periosteum pulls out from the haversian canals the outer layer of the cortex, to the blood vessels of which are attached osteoblasts. Some of these remain viable, as they are attached to periosteum with a good blood supply, and, as the toxicity of the organism diminishes, they are able to regenerate and to form new bone. Under the raised periosteum this new bone is known as the involucrum. The dead bone in the region of the abscess now has no living elements, and as time goes on the inflammatory reaction in the living bone at the junction with the dead bone is such that calcium is absorbed from the living bone by the blood, and in this way the separation is accomplished. After the separation of the dead bone, the buds of granulation tissue go out from the living elements and cover the living bone with a granulation-tissue membrane, so that the dead bone is left in a cavity. The drainage of the abscess cavity may be accomplished spontaneously or surgically. In some cases the abscess is very slow in opening and may continue for a very long period of time without drainage of any sort.

### SIGNS AND SYMPTOMS

The patient complains of stiffness in the region of a joint. This stiffness within a few hours is changed to definite pain and loss of function. The pain increases and movement in the joint, permissible at first, is soon lost, and the joint is held in a partly flexed position. General reaction supervenes, and the temperature may go to very high ranges. The outline of the joint is not disturbed for the first twelve or eighteen hours, and it may be twenty-four hours before any obvious swelling or thickening is noticed in the region of the joint. Tenderness is present very early and over a very small area. When swelling of the soft tissues occurs, it will be found to be above or below the joint, and as it increases it progresses toward the middle of the shaft. In those cases where the epiphysis is

is then, in addition to the varus element, a definitely high inner border and an inversion of the fore foot. (See Figures 2, 3, and 4.) In such feet, the peroneals are always paralyzed or weak. The loss of the counterbalancing effect of the peroneus longus on the plantar surface of the longitudinal arch leaves the strong tibialis anterior unopposed in its action and facilitates the actual development of such a change in the bony structure. The tibialis anterior has been seen in some instances to produce a recurrent calcaneus deformity when it has been left intact after stabilization of a true calcaneus foot. In these, there is also seen this same inversion of the fore foot so characteristic of the action of this muscle.

A few other recurrent deformities have been encountered as a result of other abnormal muscle pulls. Some have occurred from the abnormally strong pull of peroneal tendons transplanted to the dorsum of the foot. If the tendons are transplanted so that they are not directly in the mid-line, the fore foot can be pulled to one side or the other depending on which side of the foot is favored in the insertion. It is unusual to see peroneal tendons that have been transplanted forward develop to this extent, but a few such cases have been encountered. The majority of these were among the earlier cases where an attempt was made to place the transplant into the navicular bone itself, supposedly near the insertion of the paralyzed tibialis anterior. Two cases have been seen with a valgus deformity of the fore foot as a result of strong outer-toe extensors with complete paralysis of the peroneal group. One recurrent calcaneus deformity resulted from the action of the toe extensors alone, and one fixed recurrent equinus deformity resulted from a group of unopposed

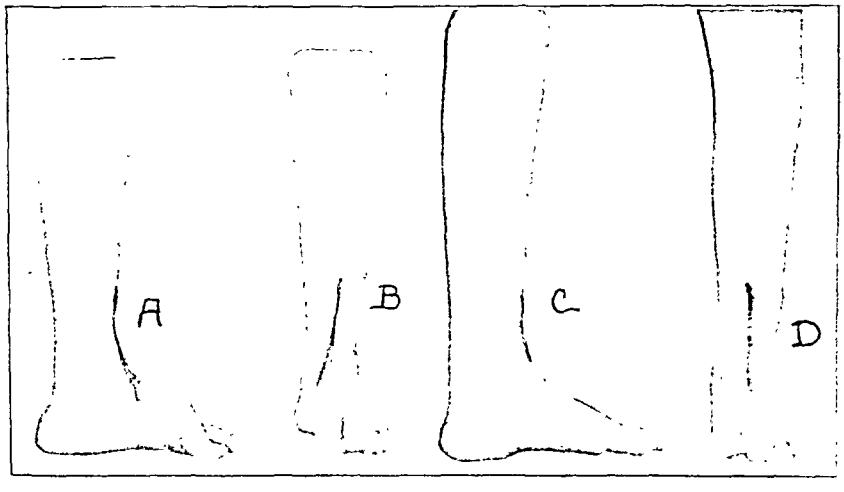
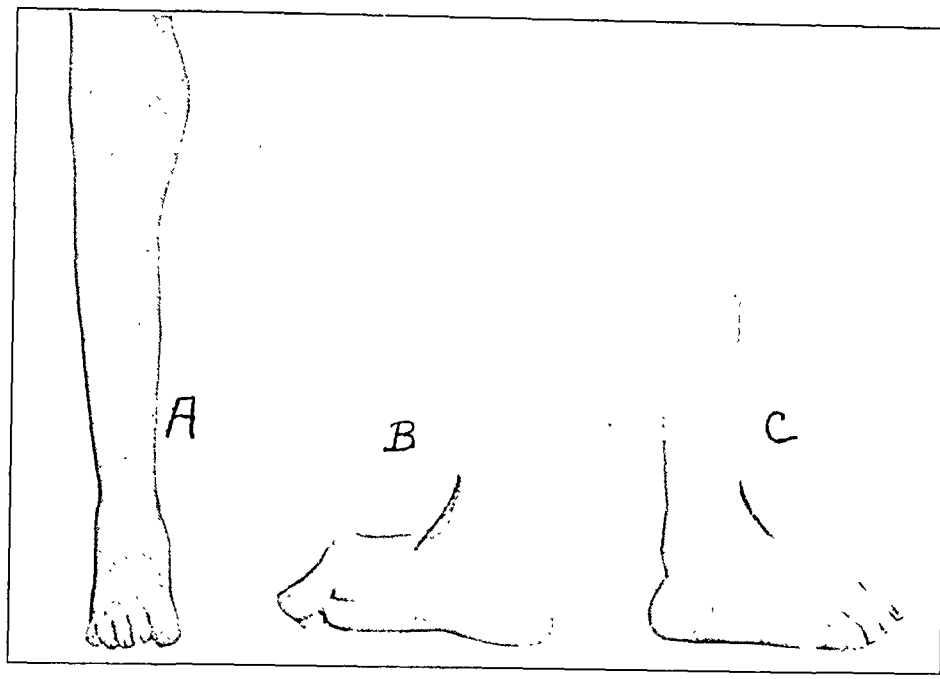



FIG. 3

*A* and *B:* Medial and anterior views of a recurrent deformity resulting from an unopposed strong tibialis anterior, three years after stabilization. Note that the heel is in good position, while the fore foot is inverted and its inner border is definitely elevated.

*C* and *D:* Similar views following reconstruction of the fore foot and transplantation of the tendon of the tibialis anterior to the mid-tarsus.



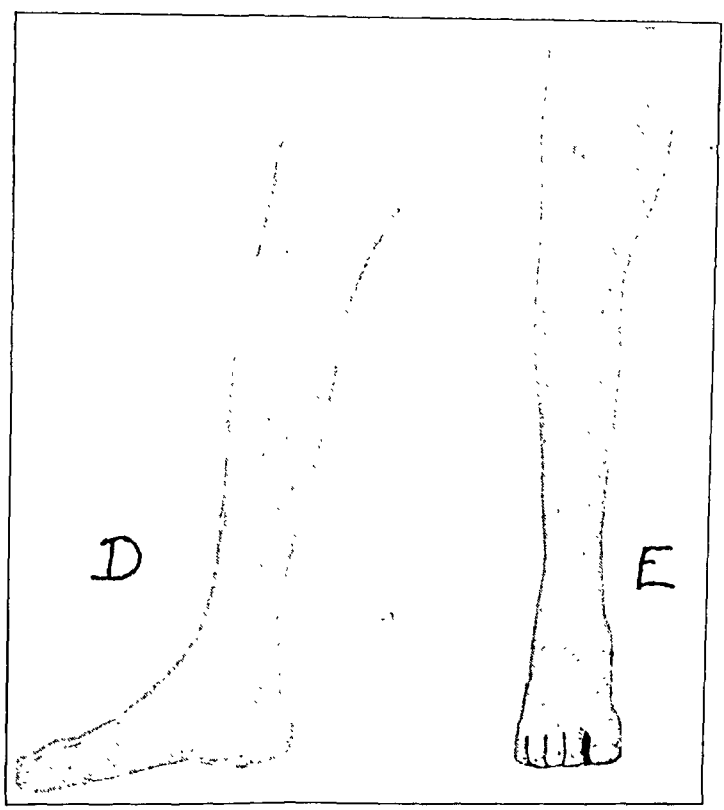




FIG. 2

A typical recurrent deformity, the result of an unopposed normal tibialis anterior.

*A:* Result following the original stabilization.

*B* and *C:* Medial and anterolateral views of the foot two years later. The heel remains in good position, but there is an inversion and adduction deformity of the fore foot.

*D* and *E:* Views of the same foot following reconstruction of the fore foot and transplantation of the tendon of the tibialis anterior to the mid-tarsus.

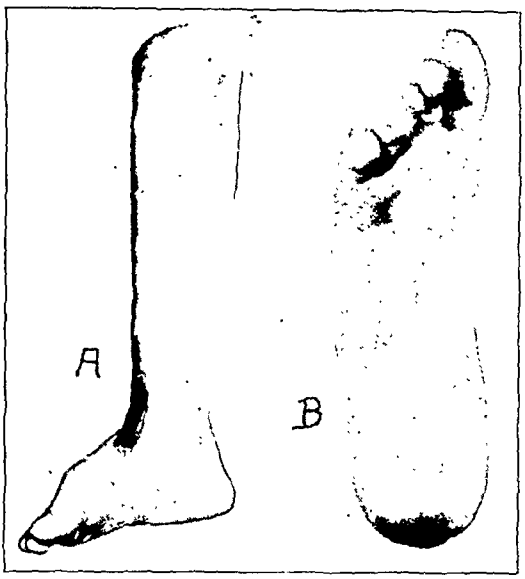
normal and unopposed tibialis anterior alone produced a recurrent deformity in thirty feet. The tibialis posterior was responsible for six recurrent deformities, while the combined pull of both served as etiological factors in twenty-seven feet. When the calf group of muscles is strong enough to prevent a true calcaneus deformity, the action of both tibial muscles produces an adduction of the fore foot, and the hind foot again remains in good position as a result of the stabilization. When the tibialis anterior is the primary etiological factor in the recurrence, however, the deformity is almost directly opposite that as described for the peroneal group. There

there is no evidence of deviation from the mid-line. If the muscles are not needed as transplants, they can be removed by the excision of a segment of the tendon five or six inches in length. We have seen tendons regenerate sufficiently, following simple section or excision of segments one inch in length, to be practically normal in power and capable of producing secondary deformities. Transplantation is usually carried out, however, as this is almost as simple as excision, preserves function in the involved muscles, and thus prevents additional atrophy and change in the contour of the leg, which is especially important in girls. The tendons on the anterior and posterior aspects of the joint must then be placed as nearly in the mid-line as possible in order to keep the foot properly aligned.

From a functional standpoint in walking, the most important muscle group about the foot is the calf group, as it must lift the entire weight of the body with each step. There is needed only sufficient power on the anterior aspect of the ankle joint to lift the weight of the foot itself against gravity. If necessary, any drop-foot tendency of importance can be controlled by the type of stabilization employed. Therefore, the muscle transplants are almost always inserted into the calcaneum. These muscle transplants must be inserted into bone if permanent satisfactory function is to be expected. When transplanted into paralyzed tendons only, they will eventually stretch the paralyzed tendons to such an extent that the function is lost.

In a varus foot, the tibialis anterior, if present, is transplanted to the mid-tarsal region, an attempt being made to place it directly in the mid-line. The tendons of the tibialis posterior and the peronei, if they show any residual power, are then transplanted to the calcaneum if the calf group of muscles is not normal; otherwise they are excised. In a varus foot with a paralysis of the tibialis anterior and a functioning tibialis posterior, the tibialis anterior tendon is not transplanted. If fair power is still present in the peroneal group, these tendons are transplanted forward to the mid-tarsal region. In some cases, the tendon of the tibialis posterior has been transplanted forward to the mid-tarsal region, but in none of these has the tendon ever functioned, and the procedure is no longer used. If satisfactory toe extensors are present, they will furnish adequate power in flexion of the foot, and no additional power in front of the ankle is needed. The extensor hallucis longus tendon is then transplanted to the neck of the first metatarsal, and the interphalangeal joint of the great toe is arthrodesed. In this type of foot, the tendons of the peronei are shifted back to the calcaneum along with the tendon of the tibialis posterior.

In valgus feet resulting from strong peroneal muscles, there is usually sufficient power in the toe extensors to ensure adequate dorsiflexion of the foot. The tendons of the peronei are then transplanted into the calcaneum along with the tendon of the tibialis posterior. If all the toe extensors are completely paralyzed in such a foot, and adequate calf muscles are present, the tendons of the peronei are transplanted to the mid-tarsal region. If the calf group of muscles is weak, however, all



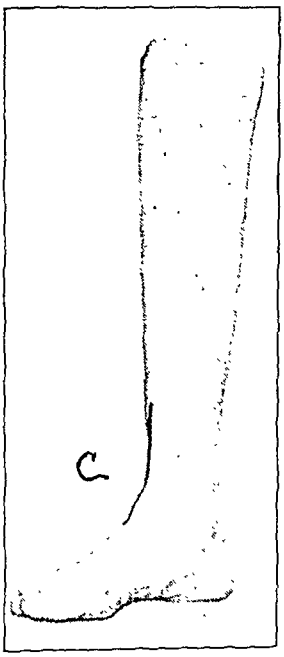




FIG. 4

*A:* Medial view of a recurrent deformity resulting from an unopposed tibialis anterior, one year after stabilization.

*B:* Plantar view of the same foot. Note the excellent position of the heel with the inversion of the fore foot.

*C:* Medial view following reconstruction of the fore foot and transplantation of the tendon of the tibialis anterior to the mid-tarsus.

normal calf muscles. Recurrent drop-foot has been controlled quite well by the type of stabilization employed in such instances, and, for that reason, fixed recurrent drop-foot deformities have been exceedingly rare. Weight-bearing itself is, of course, a major factor in the prevention of a fixed recurrent deformity of this type.

Many of these deformities have resulted from an attempt to estimate the equality of muscle power on the two sides of the ankle joint, transplanting only those tendons which were considered indicated in order to establish this equality. An example of this was the early practice of transplanting the peroneus longus tendon forward to replace a paralyzed tibialis anterior, leaving the peroneus brevis intact. In this way, much of the muscle power on the medial and lateral aspects of the ankle joint may be left undisturbed. Experience in this series of cases has proved that this is not a wise procedure, as recurrent deformities will almost invariably follow such a practice. One reason for this is that the power in individual muscles frequently changes after correction of a deformity by stabilization. A muscle may originally be very weak as a result of stretch in a marked foot deformity. Then, after correction of this deformity, much of its power may be regained, and, if left intact, may produce a deformity of the fore foot directly opposite that which originally affected the entire foot. Also, recurrent deformities have developed in many instances where muscles were left undisturbed, because it was thought that they were too weak to be of any significance.

After arthrodesis of a foot, there is no need for muscle power on the medial and lateral aspects of the ankle joint. Therefore, no muscle is now left intact on either side of the foot following stabilization, unless the muscle is known to be completely paralyzed. The only exception to this rule lies in the cavus deformity, secondary to a paralysis of the intrinsic muscles of the foot, where all the long muscles are normal in power and

transplanted into the calcaneum, and any drop-foot tendency is controlled by the type of stabilization employed. Originally the tendon of the tibialis anterior was not transplanted into the calcaneum, but was shifted over to the mid-tarsal region, and some recurrent calcaneus deformities developed. In some cases it was excised, but it often functions as an excellent transplant in spite of the fact that it has a directly opposite action, and it should always be utilized.

In simple equinus feet, the peroneal tendons are transplanted to the mid-tarsal region if they reveal sufficient power. If they are too weak for transplanting forward, the tendons are excised or transplanted to the calcaneum along with the tendon of the tibialis posterior. If any power remains in the tibialis anterior, the tendon is shifted to the mid-tarsus, which relieves the stretch on this muscle, and it frequently happens that this muscle increases in power after the deformity has been corrected. If the toe extensors are present, the extensor hallucis longus is shifted back as described previously.

### ASSOCIATED DEFORMITIES IN REMAINDER OF EXTREMITY

Recurrent deformities were seen as a result of associated malformations in the remainder of the extremity in forty-three instances. External torsion in the tibia was responsible for eighteen of these, and this associated deformity is seen almost exclusively in varus feet. (See Figures 5 and 6.) The foot should always be stabilized in proper alignment with the two malleoli and the ankle joint. When tibial torsion is present, the foot and ankle are left in a position of external rotation. This is corrected later by a transverse osteotomy of the tibia in its upper fourth, by merely rotating the distal fragment inward until the foot and ankle are placed in proper relationship to the knee joint. Some of these secondary deformities of the foot were the result of uncorrected tibial torsion, and some resulted from torsion which itself recurred after the extremity had been properly aligned at operation. The recurrent deformity in this type of foot is unquestionably

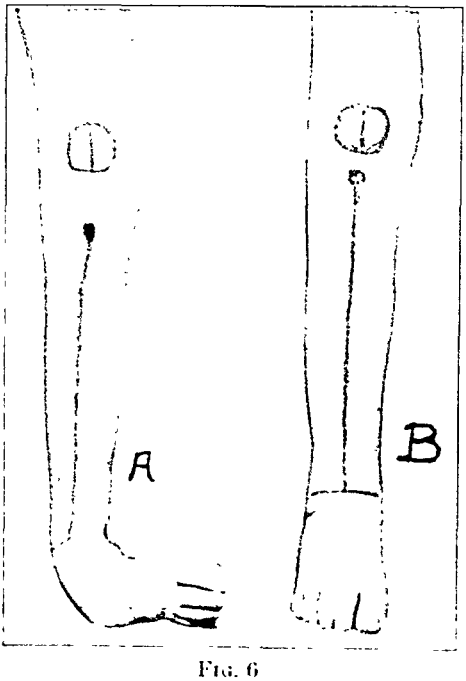



FIG. 6

*A:* Extreme varus deformity with associated external torsion of the tibia.

*B:* After stabilization of the foot, properly aligned with the two malleoli and the ankle joint, and correction of torsion later by osteomy of the tibia.

transplants are inserted into the calcaneum regardless of the status of the dorsiflexors of the foot. Here again, any drop-foot tendency can be controlled by properly shifting the foot at the time of stabilization. If any function remains in the tibialis anterior, the attachment of this muscle is shifted over to the mid-tarsal region.

In a calcaneus foot, the tendon of the tibialis anterior is passed through the interosseous membrane and transplanted into the calcaneum, together with the tendons of the tibialis posterior and the peronei, regardless of the power in the extensor tendons of the toes. If the toe extensors are still functioning, as is usually true in such a foot, the extensor hallucis longus is shifted back to the neck of the first metatarsal, and the interphalangeal joint of the great toe is fused. This prevents a cock-up of the great toe, assures a more normal looking foot, and prevents an abnormal point of weight-bearing beneath the head of the first metatarsal. Even when all the toe extensors are paralyzed, the tibialis anterior still is

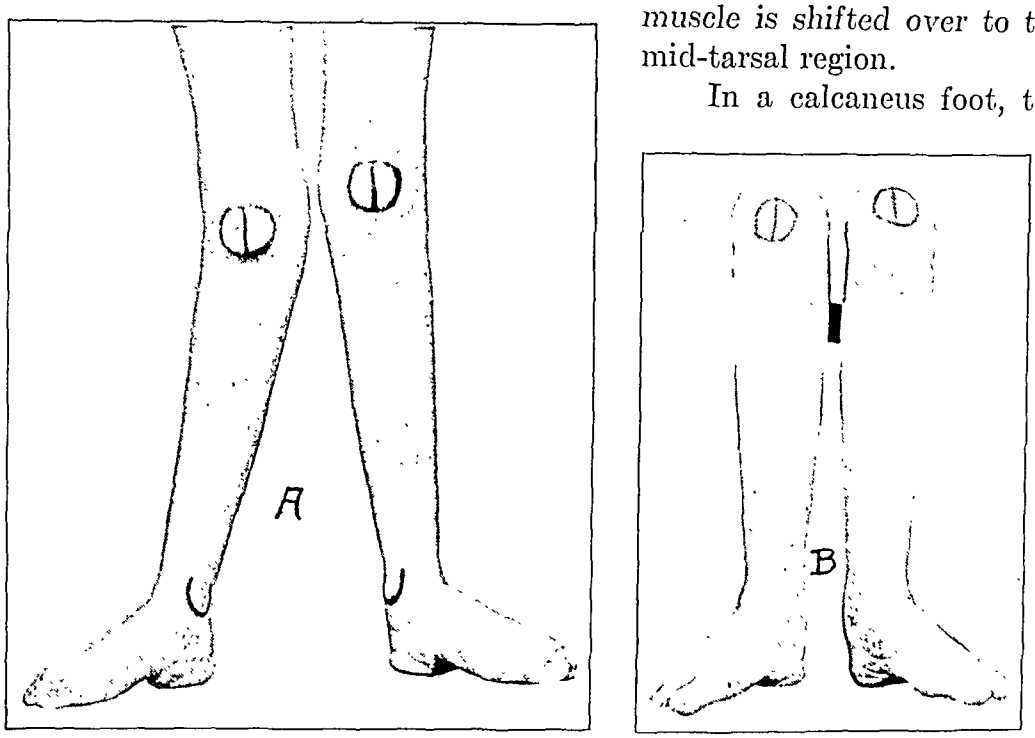



FIG. 5

*A:* Photograph on admission, showing a combination of bilateral tibial torsion and bilateral knock-knee in essentially flail lower extremities.

*B:* One month following bilateral stabilization in which both feet were placed in correct relationship to the malleoli and the ankle joint without regard to the deformity in the remainder of the extremity.

*C:* At time of discharge from the hospital after external torsion and knock-knee had been corrected on each side by osteotomy of the tibia. Note that the foot and the entire extremity are now in satisfactory alignment and afford a straight line of weight-bearing.

A combination of knock-knee and tibial torsion was responsible for recurrences in seventeen instances. (See Figure 5.) Both varus and valgus deformities were encountered in this group, and the type of recurrence apparently depends upon which of the two associated deformities is the more marked.

Recurrent deformities have been found secondary to a definite bow in the lower third of the tibia and fibula in three cases. (See Figure 7.) This type of bow is occasionally seen prior to stabilization in valgus feet. The talus is held in line with the lower end of the tibia and fibula by the two malleoli, and the foot deformity occurs at the talocalcanean joint. Therefore, since the ankle joint itself is inverted as a result of the bow, the entire foot has to be placed in a position of inversion at the time of the stabilization if it is placed in correct relationship to the ankle joint. If this is not taken into consideration at the time of arthrodesis, the foot itself is still in a position of eversion, and the valgus deformity recurs as a result. If the foot is inverted to align it properly with the ankle joint at the time of arthrodesis, the bow must be corrected later to place the weight-bearing surface of the foot in a horizontal plane. If this is not done, weight is transmitted to the outer border of the foot, and the recurrence is varus in type.

In the stabilization of any foot, it should be placed in correct relationship to the ankle joint, without regard to associated deformities in the remainder of the extremity. The deformities above the ankle are then corrected in order to place the foot and extremity in correct relationship. Tibial torsion is corrected by simple osteotomy of the tibia as previously described. Knock-knee deformities are corrected by osteotomy of the femur or of the tibia, or of both if indicated. The bow in the lower third of the leg can only be corrected by osteotomy both of the tibia and of the fibula at the maximum point of the bow.

### PATIENT TOO YOUNG WHEN STABILIZATION WAS DONE

Secondary deformities have been encountered in four cases where stabilization performed at too young an age was the only apparent cause for the recurrence. In this entire series only twenty-four feet have been stabilized in individuals below the age of seven years. Of the four patients with recurrences accounted for on this basis, three were six years and one was two years of age.

In the average child, the tarsal bones are too small and their centers of ossification are not developed sufficiently to ensure a solid bony arthrodesis prior to the age of eight years. Such an operative procedure should not be attempted in a child younger than this without determining roentgenographically the amount of bone actually present. Even in children who have reached this age, the feet are occasionally so small that roentgenograms should be obtained in order to prove the presence of adequate osseous development.

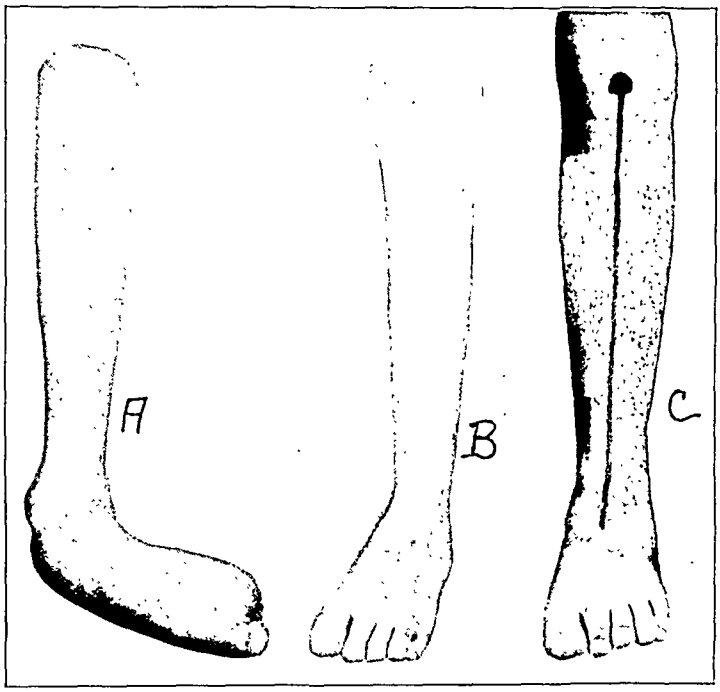



FIG. 7

*A:* Valgus deformity associated with an exaggerated bow of the lower third of the leg.

*B:* After stabilization of the foot in correct relationship to the ankle joint. In order to correct the valgus element completely in such instances, it is necessary to place the foot in a position of relative inversion.

*C:* End result following osteotomy of the tibia and the fibula in their lower thirds in order to correct this inversion, to restore a satisfactory weight-bearing surface to the foot, and to realign properly the extremity as a whole.

the result of an abnormal line of weight-bearing. There is always an attempt on the part of the patient to hold such a foot in a correct position in walking, either by internally rotating the entire extremity, or by twisting the foot inward. Various theories have been advanced for the explanation of tibial torsion and the mechanism of its development, but no adequate proof can be established that any one theory is correct. Yet, tibial torsion is encountered so frequently that its existence and its importance cannot be doubted. In the primary deformity, it is often difficult to determine whether the torsion or the varus element appeared first. In many instances they may occur simultaneously, each tending to increase the other. The foot is inverted as a result of this abnormal line of weight-bearing, and the weight is shifted to the outer border of the foot. In the original deformity, the shift takes place chiefly at the talocalcanean joint, and is prevented from rotating in the opposite direction by the contour of the articulations between these two bones. In the recurrent deformity, the change is usually primarily in the forefoot.

Simple knock-knee produced recurrent deformities in five feet. This usually produces a valgus deformity which is likewise the result of an abnormal line of weight-bearing. The foot is in a position of relative eversion as a result of this malformation, and the pressure in weight-bearing will usually cause this to increase to a fixed valgus deformity. In an adequately stabilized foot, an abduction of the forefoot alone may result. Varus deformities can occur as a result of knock-knee, and this is usually the result of an effort on the part of the individual to place the weight-bearing surface of the foot flat on the floor. This requires inversion of the foot, and a position of true inversion is substituted for one of relative eversion.

infected, swelling of the joint cavity occurs, with fluid demonstrable in the joint, and, as the condition progresses, the abscess in the epiphysis may break through into the joint cavity.

In making a diagnosis, the history is of the greatest importance, and a careful examination of the patient must be made to find out whether or not there is a skin lesion which is healing or has just healed. In the typical case the patient has sustained an injury which has caused what may be called a sprain, with soreness in the region of the joint for a day; the patient then apparently recovers, but some days later stiffness returns to the joint, and the acute reaction begins. In such a case, one of two things may have occurred. The patient may have injured the metaphysis which was already "seeded", or he may have caused an injury to the metaphysis which later became "seeded". Injury to the metaphysis is very easily brought about and is produced in the region of joints by virtue of the attachments of the ligaments of the joints in very young individuals. For instance, a hyperextension of the knee will not tear the posterior ligaments of the knee joint, but will injure the weakest part of the structure—namely, the cartilaginous point—pulling it from the end of the diaphysis. Therefore, in the diagnosis of this condition, one must look for tenderness at the part of the diaphysis that has been most liable to strain,—for instance, in the case of the femur one should look in the popliteal fossa, never at the front of the metaphysis.

A patient in whom a reaction occurs four days or longer after a fracture must be closely examined for the presence of a blood-borne infection producing a local osteomyelitis.

The examination of a child is frequently extraordinarily difficult. In the case of a fretful child and distracted parents, or of a badly trained child and mentally feeble parents, it is impossible to make an efficient examination. The author does not hesitate, and believes it is excellent practice, to give such patients an adequate dose of morphine, so that they will doze and one may examine them without any remonstrance. In such a patient in the early stages of the osteomyelitic lesion, at from eighteen to thirty-six hours, one can put a finger on an area, no larger than a twenty-five-cent piece, which is exquisitely tender and upon which pressure will cause the patient to cry out. One can repeatedly come back to this point, getting the same result, and can absolutely reassure himself of the point of tenderness. In such a patient it is generally found that there is movement in the joint which has restriction. The intense pain, the general reaction, the limitation of movement of the joint, and the local tenderness in a patient who has had a skin lesion a short time before, in whom the blood count is raised, are surely proof of an osteomyelitis of a staphylococcal nature.

There are some cases with a history, acute at first, which quiet down and remain quiet over a long period of time. In 1832 Brodie described two cases of bone abscesses that he had seen some years before. The first case he had seen in 1824. A young man, twenty-one years of age, came to

## NO DEMONSTRABLE CAUSE FOR RECURRENCE

There were only ten feet in which recurrent deformities developed which could not be adequately explained by one or more of the previously mentioned factors. Eight of these were in extremities which were completely flail and required the use of a thigh brace. In such an extremity, it is often difficult to maintain perfect alignment at all times by means of a brace. Any deviation from the mid-line shifts the line of weight-bearing to one side of the foot or the other, and, in so doing, may cause it to tilt sufficiently to initiate the development of a fixed secondary deformity. The only means of controlling such a tendency is to maintain a well-fitting and correctly aligned brace at all times.

## SUMMARY

A series of 1100 consecutive foot stabilizations for the correction of deformities associated with residual poliomyelitis has been studied with reference to recurrent deformities. In such recurrences, some form of abnormal muscle pull is the etiological factor most frequently encountered. In order to prevent such secondary manifestations, it is essential that the muscle power on the medial and lateral aspects of the ankle joint be perfectly balanced or completely removed after arthrodesis. Because of the difficulty encountered in estimating exact power in individual muscles, the peroneal and anterior and posterior tibial tendons are now transplanted to the mid-line posteriorly or anteriorly, unless the muscles are known to be completely paralyzed. If transplantation is not needed, the tendons can be excised. The only exception to this is in a cavus deformity, secondary to paralysis of the intrinsic muscles of the foot, in which all the long muscles are known to be normal in power. The exact procedure to be used in each instance obviously depends on the "set-up" in the individual foot.

Among other etiological factors are associated malformations in the remainder of the extremity. Tibial torsion, knock-knee, and an exaggerated bow in the lower third of the leg are the ones usually seen. In the stabilization of any foot, it should be placed in correct alignment with the malleoli and the ankle joint without regard to the other deformities. Procedures necessary for the correction of these deformities are then carried out at a later operation in order to establish a satisfactory line of weight-bearing in the extremity as a whole.

Four feet have shown recurrences as a result of stabilizations performed at too early an age. These can easily be prevented by waiting until the child is at least eight years of age. If the patient is younger than this, or if the foot is quite small, the presence of an adequate amount of bone should be proved by roentgenograms prior to operation.

After recurrent deformities have once developed, they are corrected by restabilization of the foot followed by removal or correction of the etiological factor in order to prevent another such recurrence.

# NON-UNION AND BONE GRAFTS *

BY LT. COLONEL NORMAN T. KIRK, M.D., SAN FRANCISCO, CALIFORNIA

When a fracture in a bone fails to unite, non-union exists. For years, six months has been accepted as a sufficiently long period to wait for union to occur. That non-union will occur can frequently be determined before this period of time by the roentgenographic appearance of the bone ends, by the separation of fragments, or by the non-appearance of radiable callus. The type of injury with its destruction of bone, soft parts, and circulation may have been the real cause of non-union; interposition of soft parts, frequent interference with bone healing by repeated early manipulations, overpull, or incomplete immobilization, infection or loss of substance may have played a part in producing it.

The accepted treatment of non-union is the transplantation of an autogenous bone graft. Ordinarily the inner surface of the tibia is used as a free transplant; the crest of the ilium or a portion of the fibula may be likewise employed. The entire fibula may be transplanted, one end at a time, to replace a marked lost substance in its adjacent tibia, as reported by Carrell and others.

Albee developed and popularized the inlay type of graft using his electrically driven saw. Henderson for years has used the "massive" type of graft, transplanting a larger fragment of bone than ordinarily used and fixing it either as an inlay or an onlay to the bone fragments with beef-bone screws. Campbell prefers the massive onlay type, using autogenous bone pegs reinforced at times by a circular wrapping of wire for fixation. Osteoperiosteal grafts, as well as multiple bone chips, have been successfully employed.

The massive type of graft finds favor because it is long, broad, and strong, and, when properly fixed to the fragments with either autogenous bone pegs or beef-bone screws, it immobilizes the fracture site. The medullary canal is reestablished; the bone ends are freshened; and throughout this area is placed cancellous and endosteal bone from the metaphysis of the tibia and from the inner surface of the graft. The success obtained by this method has been well demonstrated.

Let us consider the preparation of the "graft bed". The scar tissue between the bone ends is removed; the bone ends are freshened; and the medullary canal of both fragments is opened. When the onlay-graft method is used, the rounded cortical bone is flattened by chiseling for the reception of the flat tibial graft. It is believed that at least the outer third of the cortex should be removed, so that the blood supply of the "graft bed" will be derived from the medullary circulation and will not be limited to that supplied by the periosteum. This opinion is based on

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 18, 1938.

Robert Johnson's findings in dog experimentation that the periosteal blood supply nourishes the outer third of the shafts of the long bones and is insufficient in itself to effect healing in a fracture.[1] The inner two-thirds of the shaft is supplied by the nutrient artery and the metaphyseal vessels anastomosing with it, and, when this supply is blocked, non-union occurs.

The author is satisfied, regardless of many theories advanced, that the bone graft primarily acts as a means by which blood circulation is reestablished between the two ununited fragments, and, when and if this happens, union of the fracture occurs.

In non-union following compound fractures in which infection has occurred or osteomyelitis is present, bone-grafting should not be attempted until the wound has been thoroughly healed for at least six months and the roentgenogram is negative for sequestra or other suggestive shadows in the bone. A scar excision should then be performed; all scar tissue should be removed from the skin, from the subcutaneous and muscle layers, and from about the bone ends. If the skin cannot be closed, a pedunculated graft is used to cover the defect. All scar tissue should be removed from the extremity, and the freshened bone ends should be covered by normal muscle, scar-free subcutaneous tissue, and normal skin. If this wound heals *per primam*, the extremity is then subjected to radiant heat and massage for two weeks. If latent infection is not lighted up, one is then warranted in proceeding with the bone transplant. Of 129 cases of non-union following compound fractures, due mainly to gunshot wounds, even when this procedure was faithfully carried out, failure occurred in twenty-two because of lighting up of latent infection. In an equal number of cases infection developed in the wound, but union was fortunately obtained.

The peg type of intramedullary graft has no place in treatment of non-union, nor, for that matter, as a means of internal fixation in a recent fracture, except in the metaphysis of long bones as in the neck of the femur or in the olecranon. The beef-bone peg was outlawed years ago.

In the presence of marked bone atrophy, where the cortex is of egg-shell thickness and contains much fat and many blood vessels, the onlay type of graft cannot be fixed in position, nor can the inlay type be properly secured. Under such conditions, if the bone end is cut away, a massive type of graft, from one-half to three-quarters of an inch broad, can be pushed up into the fatty mass contained within the cortex and, thus secured, its already diminished blood supply is not further disturbed by removal of the surrounding muscle tissue and its periosteum. This is quite different from introducing a peg into the comparatively normal intramedullary canal of cortical bone. Likewise, a self-retaining partially intramedullary graft may be used successfully for non-union and loss of substance in the metacarpal and metatarsal bones.

In the pseudarthrosis type of non-union the bone is often eburnated



FIG. 1-A

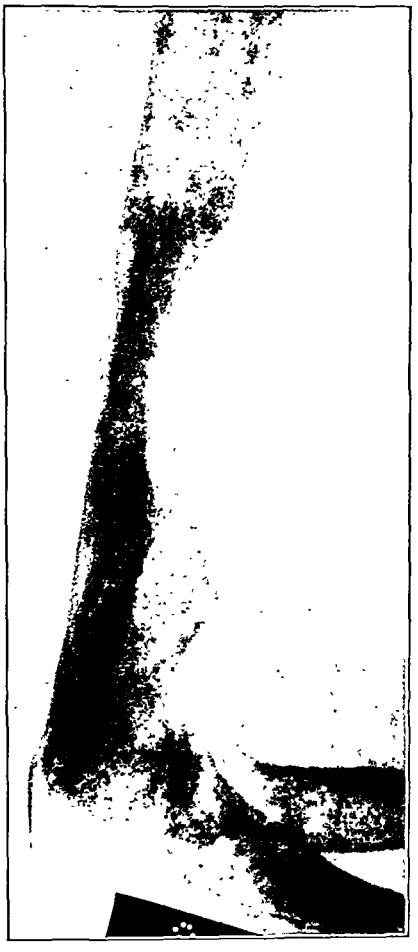


FIG. 1-B

Old gunshot wound with loss of substance and marked bone atrophy. A massive-type tibial graft was shoved up into the proximal fragment after removal of the terminal thin cortical shell. The periosteum was first removed from that part of the graft so introduced. The lower end of the graft was fitted into a slot and a pocket which were chiseled into the distal fragment. The graft was thus made self-retaining. A body plaster cast was applied several days before operation.

and avascular. It does not bleed when cut or drilled, and it corresponds to the dense scar tissue of the soft parts. The blood supply is not re-established through such bone, making regeneration impossible. Grafts at times fail when laid through or over such bone, as the blood vessels cannot penetrate it even when the sclerotic bone is drilled or otherwise broken up. This type of bone is better removed, even though loss of substance is occasioned thereby.

In the past the author has generally used the inlay graft of massive type, from one-half to three-quarters of an inch wide and from six to eight inches long, depending on the amount of lost substance or poor bone to be bridged, and being limited as to length and breadth by the size of

the donor bone. The graft should be long enough so that it has twice as much length contact with the normal bone in each fragment as the lost substance or the poor bone to be bridged. This may not always be mechanically possible.

In the forearm bones, the "fish-tail", the "diamond", and the inlay types of grafts have too often failed because the bone transplanted was not sufficiently large. The writer prefers to cut away half of the shaft of each fragment, substituting a graft the width of the forearm bone at its greatest medullary diameter and filling in the whole space with a tibial graft of this size.

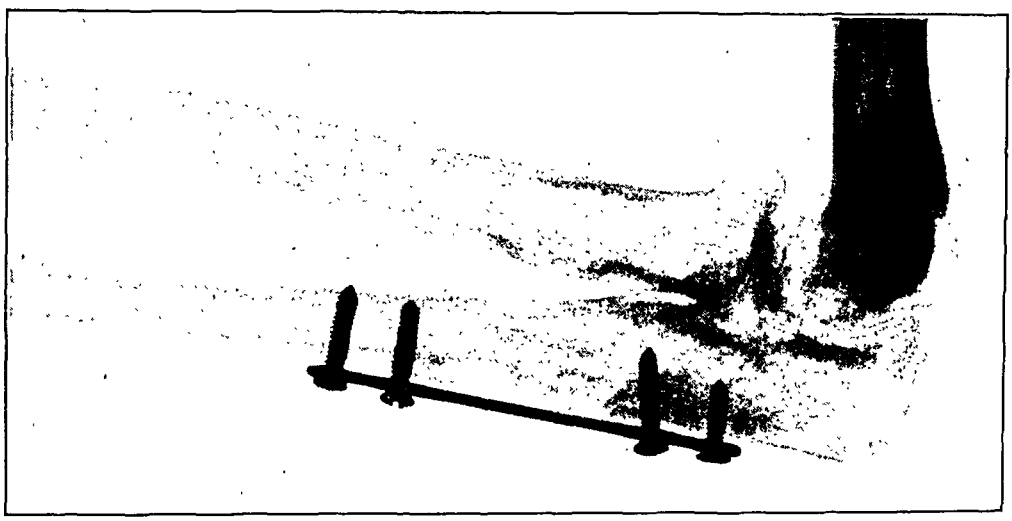


FIG. 2-A

Non-union five months after open reduction and plating of simple comminuted fracture of the upper third of the ulna, complicated by dislocation of the head of the radius and fracture with displacement of the lateral condyle of the humerus and the capitellum. The trochlea was free in the joint and was removed at the original operation.

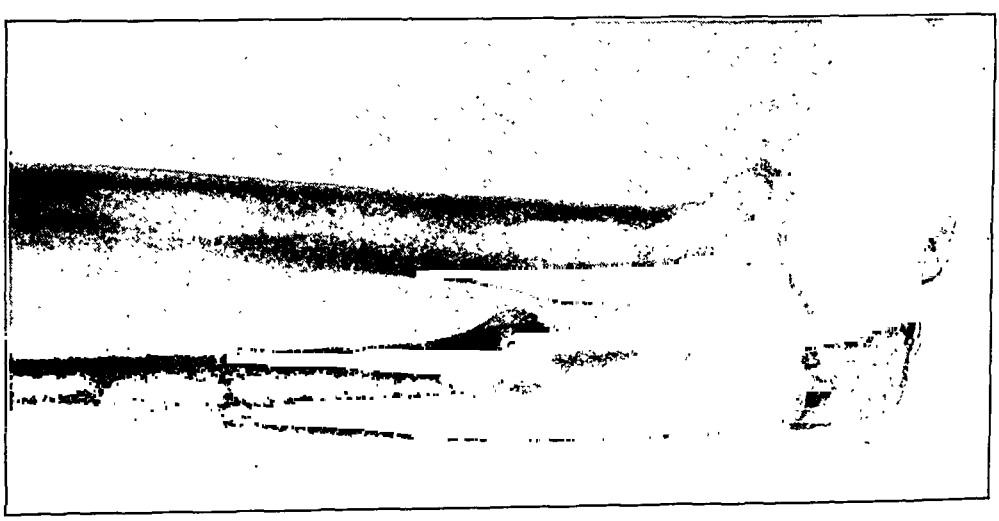


FIG. 2-B

Union ten weeks after massive type of self-retaining graft. Half of the shaft of the ulna was cut away. The ends of the cortex were notched. The tibial graft slid in from the side was made self-retaining and was further fixed with two autogenous bone pegs.

Kangaroo tendon or chromic catgut, when used to fix the graft in position in cases of non-union resulting from war injuries, frequently was not absorbed, acted as a foreign body, and caused sinus formation. For this reason, a self-retaining type of graft was developed. An inlay bed was cut with the Albee saw. The cortical bone at each end of the gutter was then beveled from above downward with a small osteotome. The graft was cut slightly longer than the gutter, and its two ends were beveled from above downward. The graft was placed in the gutter with one end fixed under the beveled cortex; the other end was then jimmied down into the gutter. With a bone set and mallet, the graft was slid toward the end last introduced. The graft then became locked into position. The leg could be picked up and vigorously shaken, and the graft maintained its position. The base of the graft bed at the fracture site was left sufficiently high to support the graft and to bring the three layers of bone,—periosteum, cortical bone, and endosteum—into apposition.

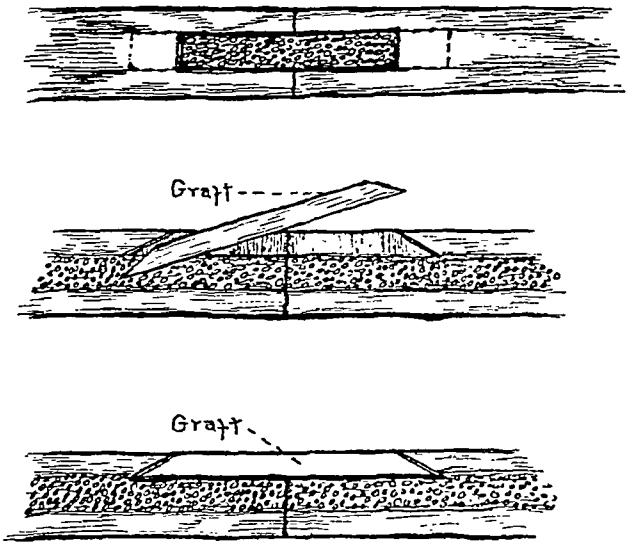



FIG. 3-A

Diagrammatic representation of self-retaining inlay graft. The cortical bone at the end of the gutter is beveled from above downward with an osteotome. The graft is cut the width of the gutter and slightly longer, and is beveled at both ends from above downward. The graft bed is cut to proper depth to support the graft at its center. Both ends of the graft lie over the normal medullary canal.

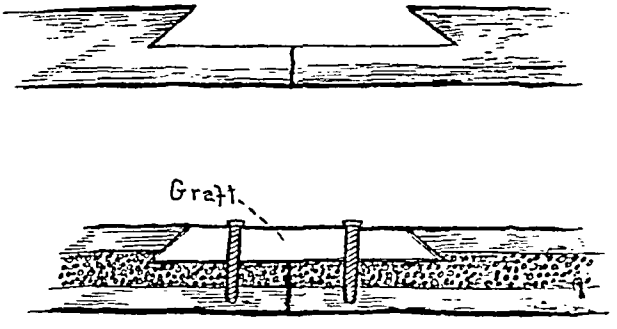



FIG. 3-B

Radius or ulna. Here half the shaft of each fragment is removed as illustrated. A graft is cut to fit the defect. It is slid in from the side, anchoring both ends below the undercut cortical bone, and is further fixed with beef-bone screws or autogenous pegs if lateral play of the fragments is feared.

The same method, using the massive graft, was employed in the forearm. The undercutting of each fragment was done by the motor saw;

the graft ends were beveled; and the graft was slid in from the side. If further fixation was needed, beef-bone screws were used.

From the fixation afforded and the results obtained, the onlay massive graft is accepted as the method of choice for non-union in the humerus and in the femur. The author prefers the self-retaining massive inlay in the tibia, but in the radius and in the ulna the self-retaining massive graft described. Absolute fixation of the graft to its bed is essential or death of the graft will occur. The graft must snugly fit its bed throughout. Autogenous bone pegs are theoretically more ideal than beef-bone screws, but mechanically they are more difficult to use and may or may not afford as good fixation. The writer has never used metal screws or wire to hold a graft in position, and has seen quite a few failures directly attributable to their use. The self-retaining graft gives ideal fixation.

Secure plaster fixation is essential, and, as soft-tissue atrophy occurs, casts must be changed to ensure immobilization. In bone-grafting operations on the humerus it is well to apply a body cast two or more days in advance to see that it properly sets, fits, and is comfortable. The arm piece is easily applied to the body cast after the operation is completed. Bivalved premade casts do not afford proper immobilization. Immobilization is continued until roentgenographic examination shows that the graft has become an integral part of the bone. From the time element, in an uncomplicated non-union this may occur almost as rapidly as the healing of a primary fracture. In old compound fractures with loss of substance, where the general circulation of the extremity has been markedly impaired, immobilization will have to be continued from two to three times as long. After removal of the cast, a properly fitted supporting brace is substituted and worn until union is firm.

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# TRANSPLANTATION OF THE FIBULA IN THE SAME LEG *

BY W. B. CARRELL, M.D., DALLAS, TEXAS

## TRANSPOSITION OF THE FIBULA FOR LOSS OF THE TIBIAL DIAPHYSIS

Perfection of technique in massive bone-grafting has reduced the indication for transposition of the fibula to a very limited field. Extensive loss of bone following radical surgery or sequestration in osteomyelitis presents a problem which in some instances is best solved by the fibular graft. After a long period of infection, the cicatricial tissue between the remaining portions of the diaphysis has little blood supply and is a poor bed for a massive free graft. The fibula, when transposed, retains much of its blood supply, and restoration is more like union of a fracture than revascularization of a bone graft. In some cases it is not even necessary to expose the entire fragment of the tibia, and the contact may be made with a minimum of trauma. This permits an early operative approach. Finally, should there be recurrence of infection, transposed bone is more likely to survive.

The procedure seems indicated definitely in two groups of cases. The first group includes those cases in which there is loss of the tibial diaphysis, even in moderate extent, but with a history of frequent reinfection. The fibula with established blood supply will live in the presence of infection. The second indication is for extensive loss of the diaphysis. With only short stubs of metaphysis remaining at each end, the fibular transplant serves well.

The following case reports illustrate the value of the method.

CASE 1. L. S., female, aged twelve years, was examined in April 1937, because of a deformity of the right leg resulting from moderate loss of the tibial diaphysis following osteomyelitis. She gave a history of frequent recurrences of infection.

On April 30, 1937, the lower end of the fibula was sectioned one and one-half inches above the malleolus and transplanted into the lower tibial fragment. The remaining portion of the fibula at the ankle was left to fuse at the upper end with the tibia to maintain ankle stability. There was some infection reaction with sinus drainage after three weeks; the sinus closed two months later.

A second-stage operation was performed on January 7, 1938. The proximal end of the fibula was exposed through a high anterolateral incision. The soft tissue, including the peroneal nerve, was reflected subperiosteally, which exposed also the plateau and lateral surfaces of the tibial diaphysis. The neck of the fibula was found firmly fused with the tibia through an area of approximately one centimeter. The part of the fibula above the fused area, which included the head and a short portion of the shaft, was excised and used as a graft to supplement the fusion. The tibial metaphysis and the adjacent surface of the fibula were denuded, and one end of the graft was inserted into the tibia; the other end rested firmly against the fibula. Small chip grafts were added for contact.

When last seen, on April 1, 1938, there was firm union.

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 18, 1938.

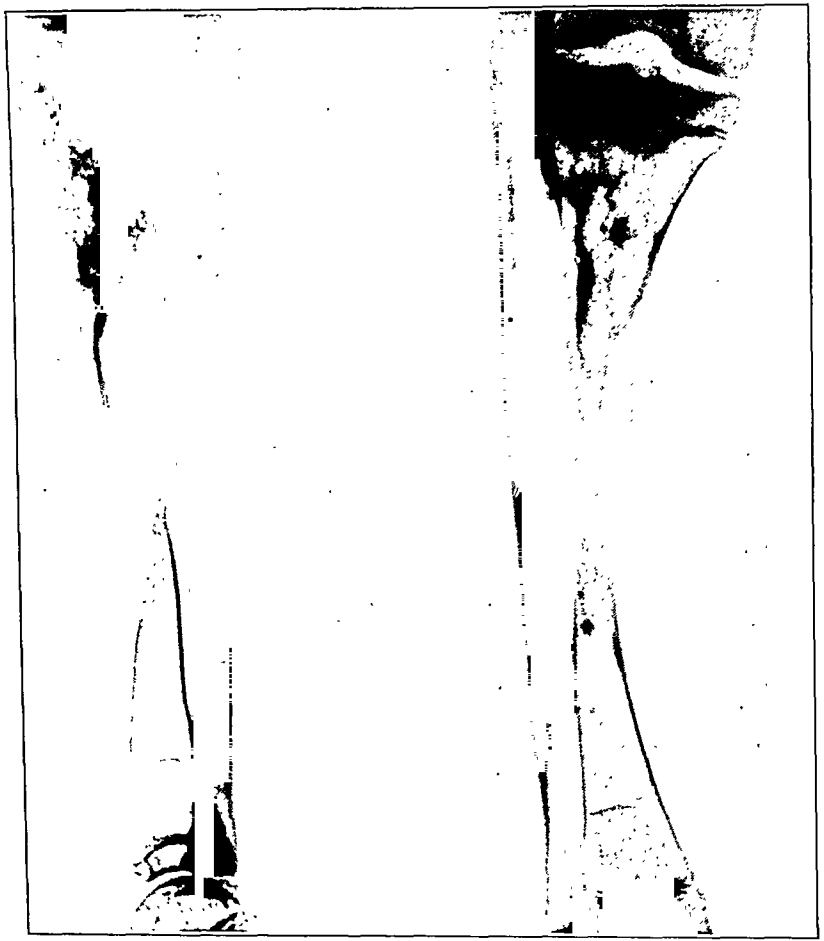


FIG. 1-A

Case 1. Lateral and anteroposterior views, showing loss of tibial diaphysis due to osteomyelitis.



FIG. 1-B

Anteroposterior and semi-anteroposterior views immediately following second operation, showing upper end of fibula, and lower end transposed eight months previously.



FIG. 2-A

Case 2. Lateral and anteroposterior views, showing loss of tibial diaphysis following osteomyelitis.



FIG. 2-B

Patient before operation.

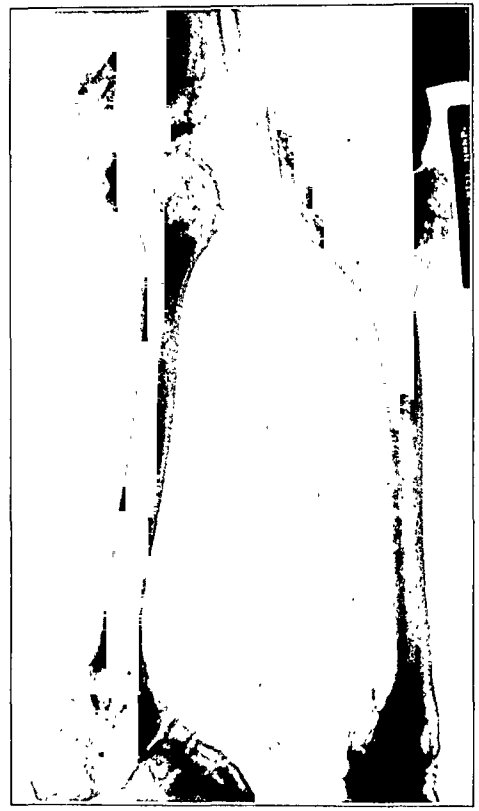


FIG. 2-C

Lateral and anteroposterior views, seven years after operation. Patient can now walk.

FIG. 3-B

Lateral and posterior views, showing transposition of the upper end of the fibula to the ankle for mortise stabilization.




FIG. 3-A

Case 3. Lateral and posterior views, showing hemangioma of the lower end of the fibula.

CASE 2. N. H., female, eight years of age, was seen on April 2, 1930, because of extreme deformity of the left leg following osteomyelitis. Examination showed loss of the entire diaphysis with four inches of shortening. The patient gave a history of severe infection starting two years previously with spontaneous drainage three weeks after onset and subsequent extrusion of many large and small sequestra. The infection continued about two years with drainage most of the time.

On admission, the sinuses near the knee had been healed for several months, and one near the ankle had been closed for thirty days. The patient had never been operated upon, although there was a heavy mass of scar on the anterior surface of the leg caused by multiple sinuses. The extreme deformity with four inches of shortening made it desirable to stabilize the leg as early as possible. Transposition of the fibula was believed to be indicated.



FIG. 3-C

Lateral and posterior views, six months after operation. Twelve months after operation, union between the graft and tibia was firm and ankle function was good.

At operation, on May 2, 1930, the entire upper end of the fibula was released, and, through the same incision, the lateral surface of the tibial fragment was exposed behind the anterior tibial muscles. A large drill hole was made to receive the fibula, and the latter, without periosteum, was levered into position. The fibula extended very close to the epiphyseal cartilage. Union occurred without infection. Because of continued sinus drainage near the ankle, the second stage of the operation was postponed for sixteen months.

A second-stage operation was performed on September 28, 1931. There had not been any drainage for the past four months. The entire lower end of the fibula was released and set through the remnant of the tibial epiphysis into the body of the astragalus. In this case, ankle motion was lost because of infection which had destroyed a part of the tibial epiphysis with invasion of the joint. The objective was a weight-bearing leg to carry the patient through childhood, with the anticipation that later amputation of the leg would be required. Healing was complete with fusion in three months and no infection.

This case is the type most suitable for transposition of the fibula. A massive free-transplant operation would have been hazardous until long after the date of the second-stage operation.

him complaining that for a year or more he had had increasing pain in the lower part of the femur, which became worse at night. On examination the femur showed some thickening, and Brodie amputated the leg. He found an abscess at the end of the diaphysis. Shortly afterward a young man, twenty-three years of age, was seen with the same history, and Brodie suspected that it was a similar case. He made an opening into the thigh, found a thickened periosteum, and, on going through this and into the bone, he found an abscess which contained pus.

This condition, known as Brodie's abscess, is now very frequently seen. When it is found in children, it is close to the epiphyseal line; in adults, it is generally a short distance from the epiphyseal line. The author considers that a Brodie's abscess is a manifestation of a preexisting osteomyelitis and that it has been "seeded" years before.

The writer recalls the history of a boy who came to the Hospital for Sick Children many years ago. He attended the Out-Patients' Clinic for two or three weeks and received treatment for a sprained ankle. It was in the early days of the roentgen ray, and the roentgenogram did not reveal any abnormality. Fifteen years later the boy complained of pain in the lower part of the tibia, and on examination he was found to have a thickened tibia. An abscess was revealed about two inches above the lower epiphysis. It was drained and found to contain staphylococci.

There is no doubt that organisms can reach an equilibrium or come close to an equilibrium in the tissue in which they lie and in the part of the body in which they live. It is a well-known fact that scar tissue associated with a badly infected compound fracture may harbor organisms for many years. It is an extraordinary thing that these infected areas may carry their infection over a long period of years, and cause no increase in titer or symptoms of intoxication. A woman with a Brodie's abscess, giving symptoms fifty years after an acute osteomyelitis, had a titer of 0.4. If a fair opportunity presents itself, the bacteria commence to grow, and they may kill their host in forty-eight hours with a raging septicaemia. One may open a Brodie's abscess which has given no symptoms excepting that of pain, and immediately the patient runs a high fever and gets a general reaction, and a septicaemia may even develop, which is very important. When death follows the opening of such an abscess, one wonders if it is due to the liberation of toxin. If so, these cases would be better treated by a preliminary course of toxoid.

## TREATMENT

There have appeared recently in the literature suggestions that in this condition early operation should not be performed. Some years ago the author felt that, if a diagnosis could be made early in the disease, and, if the local lesion could be drained, one could expect an improvement or a limitation of the disease. Formerly, therefore, it was his practice to operate early upon the lesion, and in this connection he considers Orr's treatment a really great advance both from the standpoint of the patient's

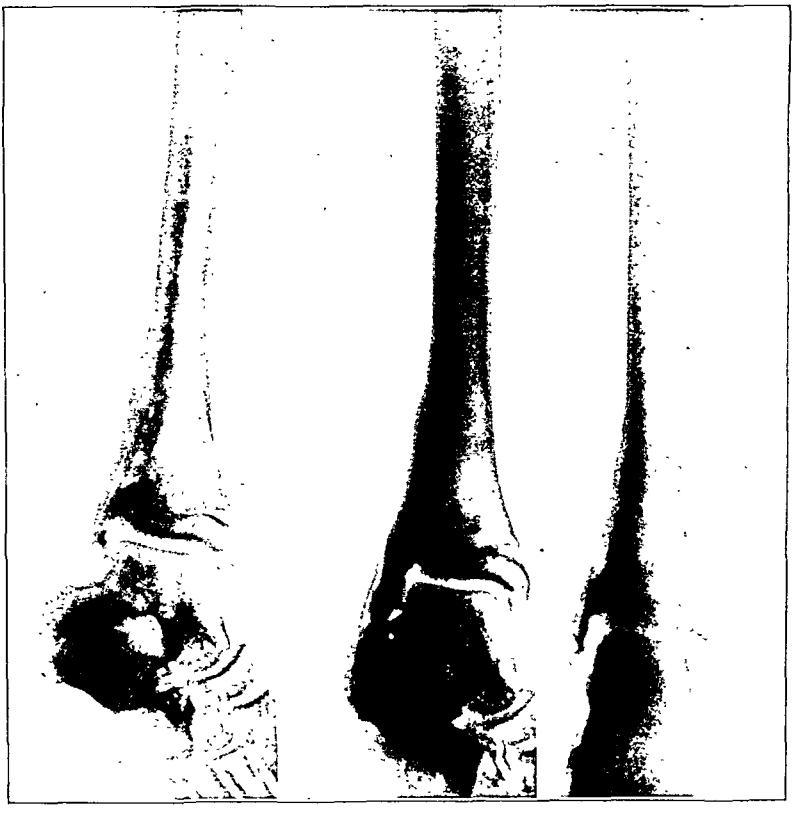


FIG. 4-C
Two years after operation.

TRANSPOSITION OF THE FIBULA TO RESTORE ANKLE MORTISE

The size and shape of the head of the fibula are well adapted to support the lateral side of the ankle when transplanted. The procedure is illustrated in the following case reports.

CASE 3. Mrs. R.C.K., aged forty-five years, was seen because of a slight swelling on the outer aspect of the right ankle. The clinical diagnosis was giant-cell tumor.

At operation, the lower third of the fibula, with the tumor, was removed. The proximal portion was released through a separate incision over the head of the fibula by stripping the soft tissue from the periosteum. The bone was then pulled through the lower incision and transplanted at the ankle. The attachment of the biceps was sutured to the fascia lata and capsule of the fibula. The fibular graft and the lateral side of the tibia were prepared by roughening the surfaces which would be in contact. In placement, the head of the fibula was against the side of the astragalus and formed an outer support for the ankle. The graft was held in firm position through the use of a special screw, which compressed it against the tibia.

An interesting fact in the history, although irrelevant to the subject under discussion, is that five months after operation a tumor was discovered in the femoral condyle of the same leg. Two months prior to discovery, the patient had sustained an injury to this portion of the knee.

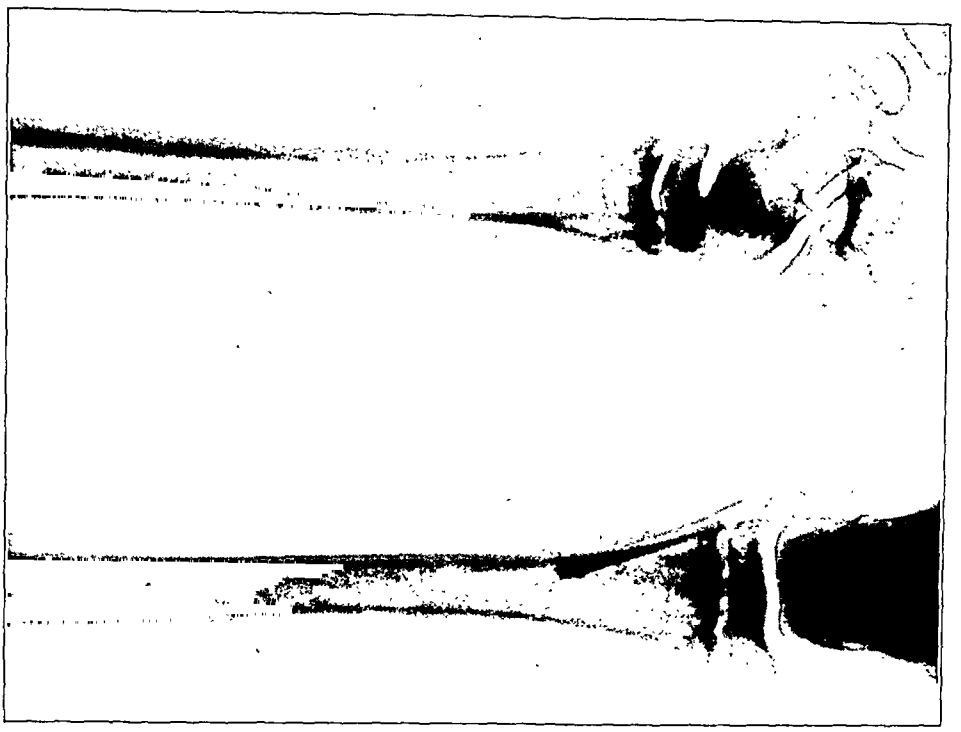


FIG. 4-B

Posterior and lateral views, showing upper end of fibula moved to lower end for preservation of ankle mortise.

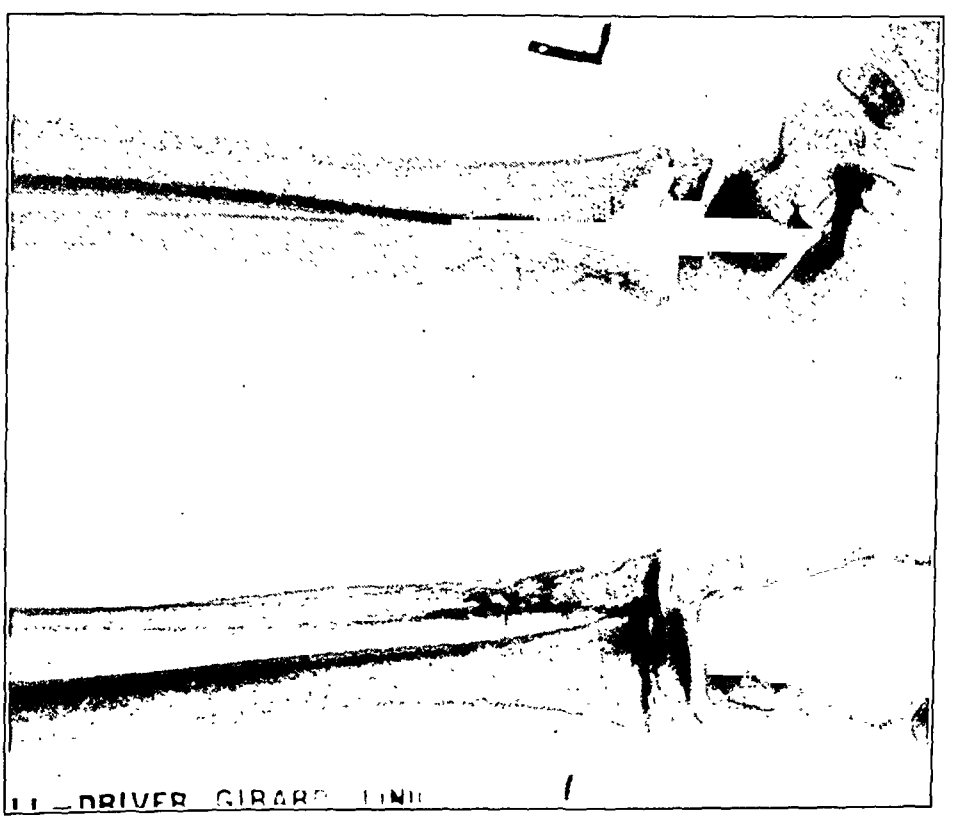


FIG. 4-A

Case 4. Posterior and lateral views, showing Ewing's sarcoma of the fibula.

# BONE GRAFTS IN UNUNITED FRACTURES *

BY MELVIN S. HENDERSON, M.D., ROCHESTER, MINNESOTA

*From the Section on Orthopaedic Surgery, The Mayo Clinic*

Bone-grafting came into general use in the treatment of ununited fractures about 1912. The basis for the present paper is a review of the records in all cases in which transplantation of bone for ununited fractures was carried out at The Mayo Clinic during the twenty-five-year period from 1912 to 1936, inclusive. There were 583 patients so treated; the end results are known for 530. Of these, 462, or 87 per cent., were treated successfully, and bony union was obtained; whereas sixty-eight, or 13 per cent., were not so fortunate, and the results must be classified as failures. Except in a few instances, wherein a graft from one individual was transplanted in another, an autogenous graft was used.

Not all ununited fractures were treated by a bone-grafting procedure. Certain fractures of the humerus, for example, were "stepped", and side-to-side apposition was obtained; others, particularly ununited fractures of the lower third of the femur and, occasionally, of the tibia, were freshened and lined up. In some cases the malposition and deformity were such complicating factors in the operation that, to save time, metal plates or bands were used for fixation. The use of metal is frowned upon by many authorities, but difficult operations, with the accompanying trauma and long exposure of tissues, definitely raise the percentage of infection; therefore, in order to shorten the procedure, metal may well be employed. The end results in our cases at The Clinic in which we did rely on metal have justified the procedure.

Hindsight will only be better than foresight if we study our failures and mistakes, so, with the aid of Dr. Herman Young, we picked out from the 530 traced cases the records of the sixty-eight patients unsuccessfully treated and studied them closely. This study has served to emphasize certain very definite dangers and unfavorable factors,—some of them avoidable, others unavoidable. Although we were previously aware of them, there is nothing like cold figures to drive home the truth. The percentage of failures is higher than the author would like to have it, but, in all fairness and not in apology, it must be pointed out that the period covers the early days of bone-grafting when the technique was not well developed. Also, in many of these patients the fractures had existed in a state of non-union for years; many patients had been operated on previously, some a goodly number of times; and a large percentage of the fractures had been caused by severe trauma and had been previously infected. There are many factors concerned in the management of these cases that

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 18, 1938.

and a slight swelling had appeared, lasting a few days. This swelling had reappeared after three weeks. Roentgenograms of the knee revealed a tumor with the appearance of a benign giant-cell growth. Roentgenotherapy was given. The pathological diagnosis of the tumor removed from the ankle was hemangioma of the capillary type.

CASE 4 (Registry of Bone Sarcoma, No. 1943). J. A. S., female, six years of age, two months prior to examination, had received a severe bruise on the outer side of the left ankle. The swelling had lasted several days, and soreness had persisted for the entire period. Two weeks before examination the swelling had reappeared, but the mother stated that it seemed a little different in that it had a firmer character.

Examination revealed a firm fusiform thickening over the lower two inches of the fibula, which, in the roentgenogram, had the appearance of Ewing's sarcoma. The suspected diagnosis was proved by biopsy. Roentgenotherapy was instituted, and six months later recession of the tumor was evident roentgenographically.

At operation, on February 4, 1935, the lower end of the fibula and the tumor were excised and the upper end of the bone was transposed for support of the ankle mortise. Great care was exercised to preserve the upper epiphysis without injury and to transplant the graft in such position that the shaft of the tibia would not carry it up the leg in its future growth. The graft was imbedded into the tibia just proximal to the epiphyseal plate, and directed away from the epiphysis as it crossed the ankle joint.

Two years after operation there was two centimeters of shortening in the leg, probably due to the roentgenotherapy. (Fourteen treatments were given during the six months before operation.) The graft had grown in length and in size and until that time the epiphyseal line was distinctly shown in roentgenograms. It had the same relationship to the ankle as when introduced, and stability was good.

Of interest in tumor therapy is the unanimous opinion by members of the Registry in regard to the biopsy diagnosis of Ewing's sarcoma. After roentgenotherapy for six months, the specimen removed at operation was free from any structure resembling tumor tissue.

### LENGTH OF TIME UNUNITED FRACTURE EXISTED

Some fractures still show evidence of an attempt at repair as long as two or three years after injury, whereas a fracture only a few months old may exhibit complete inertia. In this study the author has attempted to make no sharp differentiation between delayed union and non-union, because he believes that the length of time during which the fracture has been ununited is of comparatively minor importance. Union has been readily secured in fractures that have existed for as long as eighteen years, and union has failed in fractures that have existed only a few months. Much depends upon the condition of the bone fragments, the blood supply, the amount of scar tissue present, etc. Osteoporosis consequent to non-use is of little importance and can be disregarded, but osteoporosis accompanying osteogenesis imperfecta is unfavorable and should be overcome as much as possible before operation.

The question is often asked: How long should one wait before performing transplantation of bone for an ununited fracture? The opportunity of choosing the time has by no means been our privilege, because patients with such fractures come from widely scattered areas and one seldom sees a delayed union in one's own practice. This series of cases, therefore, does not answer that question, but the longest time that an ununited fracture had existed in our series was nineteen years; the shortest, two and a half months; and the average duration, three years.

In so far as the condition of the bones is concerned, the writer believes that an ununited fracture which has been present for years offers practically as favorable an opportunity for bone-grafting as does one of shorter duration, although the accompanying deformity—that is, the malposition of the fragments, particularly in the lower extremity—is often a problem in itself and does very definitely complicate the procedure. Consequently, other things being equal, one would expect in any given two series studied for comparison that the series with an average shorter duration of non-union would give somewhat better results than the one composed of cases of fracture of longer duration.

### PREVIOUS TREATMENT

The scarring following previous operations and perhaps infection was in many cases an unfavorable and hazardous condition that could not be avoided. The incision should always be made through the soundest tissue possible. In previously infected cases, the longer the time between the cessation of all drainage and the operation, the better the chances of avoiding subsequent infection and drainage. A smooth, movable, cool, white scar is desirable. We now make it a rule never to operate on a patient less than six months, and seldom under a year, after the cessation of drainage. Operation should be postponed as long as the scar remains red and inflamed.

### THE BONE INVOLVED AND THE SITE OF FRACTURE

As bones differ in their shape and size and so present different me-

the writer would like to discuss, but to obviate the possibility of confusion, the present paper will be confined to what he considers the major points.

### SEX AND AGE

Sex is of no importance; as might be expected, most of the patients were males. Age is of definite importance. As will be pointed out in our series of cases of fracture of the tibia, the percentage of poor results is notoriously high for ununited fractures sustained at birth, in early infancy, in childhood, or even in adolescence. While ununited fractures in the elderly are not as easily dealt with as those occurring in middle life, they are quite adaptable to bone-grafting procedures provided the patient's general condition is good. As a matter of fact, old age is no bar to sound surgery of any kind, provided shock (which is usually caused by excessive loss of blood) and trauma incident to prolonged operations are avoided.

### GENERAL CONDITION OF PATIENT

The health of the group of patients under consideration was remarkably good and poor results could not be attributed to their general condition. Syphilis has often been mentioned as a factor in the production of ununited fractures, but this has been far from our experience, nor is there any proof that it was a factor in the failures in this series. Only two patients gave positive histories of syphilis, and both had negative flocculation tests. Calcium and phosphorus studies were made in a great many cases, but the values were practically normal in all. Phosphatase has been estimated of late years, but it is of no clinical significance. Ununited fractures due to osteogenesis imperfecta are truly difficult to treat successfully. If a diabetic patient is to be operated on, the operation must be well planned, for such patients do not stand prolonged operations at all well and the cooperation of an internist should be secured to watch over the postoperative course.

### INITIAL INJURY

When the injury is of a very severe type—such as a crushing, twisting, or bruising trauma—so much damage is done to the bone and the soft parts that the reparative power of the bone may be permanently kept below par. We believe this was a prominent factor in many of our cases with poor results. Damage to the soft parts is very important,—in dealing with fresh fractures, we have seen many badly comminuted ununited fractures, unaccompanied by injury to the soft parts, that finally united even though union was often delayed. The initial injury may have been a compound fracture, leading to the production of severe infection and scarring, and causing a decreased blood supply to the surrounding tissues and, consequently, to the bone. Scar tissue in the operative field is particularly bad, for sloughs may follow, which provide an ideal field for infection carried by the blood stream. A considerable number of our cases of infection developed late in just that way.

twenty failures; in the 218 cases of fracture of the tibia, twenty-one failures; in the ninety-one cases of fracture of the humerus, thirteen failures; in the fifty-seven cases of fracture of the radius, four failures; in the twenty-eight cases of fracture of the ulna, three failures; in the thirty-nine cases of combined fractures of the radius and the ulna, six failures; and in the four cases of fracture of the clavicle, one failure. (See Table I.)

*Fractures of the Femur*

There were fifty-seven cases in which fractures of the neck of the femur were treated by bone grafts and in which the results are known. The results were successful in forty-five, or 79 per cent., of the cases and failures in twelve, or 21 per cent. (See Table II.) Failures in the treatment of fractures of the neck of the femur are very discouraging when they do occur, for the patients are usually elderly and the time spent is regrettable, since the life expectancy of such patients is naturally low. This much can be said: The head of the femur must be viable; there must be sufficient femoral neck left to work with; the fibrous tissue of the union must be dissected out; and the bone ends must be freshened and accurately fitted if the maximal results are to be obtained. Postoperative fixation must be as complete as possible for at least three months. A review of our records made it plain that our failures were accounted for mostly by non-fulfillment of the foregoing conditions. If the fracture surfaces are not held closely together, the bone graft atrophies and breaks at the site of fracture, for it will not bridge the gap. We had three postoperative infections in this group that were factors in the failures.

In so far as fractures of the femoral shaft are concerned, whether the fracture is in the upper, the middle, or the lower third seems to be of some importance, because, in the lower third, the percentage of failures was 33 as against 20 and 22 in the middle and upper thirds, respectively. However, only eight bone grafts were done on the lower third of the femur. The reason that there were so few is that there is such a breadth of bone in that location that we are content to secure good, broad, bony apposition of the fragments and to maintain it with a metal plate. The results of this procedure are very good, and the technique is much simpler than if a bone graft is used.

*Fractures of the Tibia*

Our experience with ununited fractures of the tibia clearly showed that the age of the patient can be a definite factor. Whereas the percentage of failures for the total number was 10, if the cases of individuals less than twelve years of age are excluded (nine cases or 43 per cent. of the total tibial failures), our percentage of good results jumps to 94 per cent. with failure in only 6 per cent. Treatment of the twenty-two fractures in the upper third was successful in all cases, whereas in the eighty-nine fractures in the middle third failure resulted in 8 per cent. and in the 107 fractures in the lower third treatment failed in 13 per cent., indicating that the

TABLE I

SUMMARY OF CASES OF UNUNITED FRACTURES TREATED BY BONE GRAFT AT THE MAYO CLINIC FROM 1912 TO 1936 INCLUSIVE

| Bone Involved | Total Cases | Cases Traced | Results | |
|---|---|---|---|---|
| | | | Successful | Failure |
| Femur | 100 | 92 | 72 | 20 |
| Tibia | 233 | 218 | 197 | 21 |
| Humerus | 100 | 91 | 78 | 13 |
| Radius | 70 | 57 | 53 | 4 |
| Ulna | 30 | 28 | 25 | 3 |
| Radius and ulna | 44 | 39 | 33 | 6 |
| Clavicle | 5 | 4 | 3 | 1 |
| Metatarsal | 1 | 1 | 1 | 0 |
| Total | 583 | 530 | 462 (87 per cent.) | 68 (13 per cent.) |

chanical problems, there is a consequent variation in the percentage of successful results. In this series the highest percentage of failures occurred in fractures of the femur. The site of the fracture in the bone—whether in the upper, the middle, or the lower third—is of considerable importance. In the ninety-two cases of ununited fracture of the femur, including the femoral neck, in which patients were traced there were

TABLE II

UNUNITED FRACTURES OF THE FEMUR TREATED BY BONE GRAFT (1912–1936)

| Site of Fracture | Total Cases | Cases Traced | Results | | | |
|---|---|---|---|---|---|---|
| | | | Successful | | Failure | |
| | | | *No.* | *Per Cent.* | *No.* | *Per Cent.* |
| Neck | 61 | 57 | 45 | 79 | 12* | 21 |
| Upper third | 9 | 9 | 7 | 78 | 2 | 22 |
| Middle third | 22 | 20 | 16 | 80 | 4 | 20 |
| Lower third | 8 | 6 | 4 | 67 | 2 | 33 |
| Total | 100 | 92† | 72 | 78 | 20‡ | 22 |

* Includes 3 cases of postoperative infections with loss of grafts and 9 cases in which the grafts became absorbed and fractured.

† 17 per cent. of total of 530 traced cases.

‡ 29 per cent. of total of 68 failures.

comfort and of his own protection. Recently the writer has felt that an early operation gives no help to the patient. The problem in an early case is one of combating a blood infection and dealing with the toxins and organisms that are present, and until some approach to an equilibrium has been reached surgery, in so far as incision of a local lesion goes, has nothing to offer. When the condition has reached a point where pus is present, then simple drainage may be of advantage.

## CONCLUSIONS

1. Staphylococcal hematogenous osteomyelitis is a clinical entity.
2. The blood is most frequently infected from a skin lesion.
3. It is a disease of youth, the metaphysis, the periosteum, and the medulla of the epiphysis being infected.
4. Children with skin lesions should be restricted in their physical activities, and toxoid should be administered.
5. Administration of antitoxin intravenously is not a safe procedure.
6. Toxoid will raise the titer in some cases where infection has not done so.
7. No case should be operated upon in which there is not a definite abscess.

The author wishes to express his indebtedness to the Connaught Laboratories of the University of Toronto in which the studies of the blood titers have been made. Dr. C. E. Dolman and Dr. J. S. Kitching especially have been most generous with their assistance. Dr. W. S. Keith also has done arduous work in gathering statistics of the clinical cases.

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TABLE III

UNUNITED FRACTURES OF THE TIBIA TREATED BY BONE GRAFT (1912–1936)

| Site of Fracture | Total Cases | Cases Traced | Results | | | |
|---|---|---|---|---|---|---|
| | | | Successful | | Failure | |
| | | | *No.* | *Per Cent.* | *No.* | *Per Cent.* |
| Upper third | 24 | 22 | 22 | 100 | 0 | 0 |
| Middle third | 92 | 89 | 82 | 92 | 7 | 8 |
| Lower third | 117 | 107 | 93 | 87 | 14 | 13 |
| Total | 233 | 218* | 197 | 90 | 21† | 10 |
| Patients less than 12 years old | 20 | 19 | 10 | 53 | 9 | 47 |
| Adults | 213 | 199 | 187 | 94 | 12 | 6 |

* 41 per cent. of total of 530 traced cases.
† 31 per cent. of total of 68 failures.

lower third is the most unfavorable site in the tibia for this procedure. There were two failures in cases of adolescents with fractures in the middle third, and seven in cases of those with fractures in the lower third. (See Table III.)

*Fractures of the Humerus*

The site of the lesion is of prognostic importance in ununited fractures of the humerus. In the twelve cases of fracture in the upper third there were two failures; in the forty-three cases of fracture in the middle third, two failures; and in the thirty-six cases of fracture in the lower third, nine failures. The percentage of failures for this whole group was 14. (See Table IV.)

Ununited fractures of the lower third of the humerus are thus shown to be an unfavorable group, and the different steps of the operation must, therefore, be carefully planned. All evidence of previous infection must have disappeared before treatment is undertaken. Adequate contact of the fragments and fixation of the bone graft must be secured, particularly to the lower fragment which is often quite short and difficult to control, owing to stiffness of the elbow. Infections seemed to have been definitely the cause of four of our failures, and these infections developed in the five cases in which there had been previous infections; in only one case of this group did healing take place by primary intention. Pressure is too often put upon the surgeon to operate because the patient can ill afford to wait, being far from home, etc., but to yield before all evidence of inflammation has subsided is to regret it later. In four of the cases of failure, while sepsis was not present, the graft fractured during convalescence, probably because contact of the fragments was faulty. In one case an

TABLE IV

UNUNITED FRACTURES OF THE HUMERUS TREATED BY BONE GRAFT (1912–1936)

| Site of Fracture | Total Cases | Cases Traced | Results | | | |
|---|---|---|---|---|---|---|
| | | | Successful | | Failure | |
| | | | *No.* | *Per Cent.* | *No.* | *Per Cent.* |
| Upper third | 13 | 12 | 10 | 83 | 2 | 17 |
| Middle third | 46 | 43 | 41 | 95 | 2 | 5 |
| Lower third | 41 | 36 | 27 | 75 | 9* | 25 |
| Total | 100 | 91 | 78 | 86 | 13 | 14 |

* Previously infected in 5 cases, and in 4 of these 5 cases became infected after operation. In none of cases without previous infection did infection develop following operation.

accident in handling while taking a roentgenogram about eight weeks post-operatively resulted in fracture of the graft.

*Fractures of the Radius Alone*

In this group there were fifty-seven traced cases with four failures, or 7 per cent. (See Table V.) There were fourteen cases of fracture in the upper and middle thirds with no failures, and forty-three in the lower third with four failures. In cases of fracture of the lower third of the radius it is difficult to obtain correct alignment because of ulnar deflection of the upper end of the lower fragment with consequent radial deflection of the hand and the wrist. However, such deformity must be corrected to obtain good function, and adequate contact of the graft with the lower fragment must be secured.

TABLE V

UNUNITED FRACTURES OF THE RADIUS TREATED BY BONE GRAFT (1912–1936)

| Site of Fracture | Total Cases | Cases Traced | Results | | | |
|---|---|---|---|---|---|---|
| | | | Successful | | Failure | |
| | | | *No.* | *Per Cent.* | *No.* | *Per Cent.* |
| Upper third | 3 | 1 | 1 | 100 | 0 | 0 |
| Middle third | 17 | 13 | 13 | 100 | 0 | 0 |
| Lower third | 50 | 43 | 39 | 91 | 4 | 9 |
| Total | 70 | 57 | 53 | 93 | 4 | 7 |

TABLE VI

UNUNITED FRACTURES OF THE ULNA TREATED BY BONE GRAFT (1912–1936)

| Site of Fracture | Total Cases | Cases Traced | Results | | | |
|---|---|---|---|---|---|---|
| | | | Successful | | Failure | |
| | | | *No.* | *Per Cent.* | *No.* | *Per Cent.* |
| Upper third | 10 | 10 | 9 | 90 | 1 | 10 |
| Middle third | 13 | 13 | 12 | 92 | 1 | 8 |
| Lower third | 7 | 5 | 4 | 80 | 1 | 20 |
| Total | 30 | 28 | 25 | 89 | 3 | 11 |

*Fractures of the Ulna Alone*

In this group there were twenty-eight traced cases with three failures, or 11 per cent. There were ten cases of fracture in the upper third, with one failure; thirteen in the middle third, with one failure; and five in the lower third, with one failure. (See Table VI.) Here again fractures in the lower third seem to be the most difficult to treat.

*Fractures of the Radius and the Ulna Combined*

In this group there were thirty-nine traced cases with six failures, or 15 per cent. There were three cases of fracture in the upper third, with no failures; nineteen in the middle third, with four failures; and seventeen in the lower third, with two failures. (See Table VII.) It is difficult to evaluate percentages fairly in this group, because if one bone united and the other did not, we classified the result as a failure. Also, the bones were occasionally operated on separately several months apart. According to our figures, fractures in the middle third seem to be the most difficult to deal with.

TABLE VII

UNUNITED FRACTURES OF THE RADIUS AND THE ULNA COMBINED TREATED BY BONE GRAFT (1912–1936)

| Site of Fracture | Total Cases | Cases Traced | Results | | | |
|---|---|---|---|---|---|---|
| | | | Successful | | Failure | |
| | | | *No.* | *Per Cent.* | *No.* | *Per Cent.* |
| Upper third | 3 | 3 | 3 | 100 | 0 | 0 |
| Middle third | 23 | 19 | 15 | 79 | 4 | 21 |
| Lower third | 18 | 17 | 15 | 88 | 2 | 12 |
| Total | 44 | 39 | 33 | 85 | 6 | 15 |

### MASSIVE BONE GRAFT

For twenty years or more at The Mayo Clinic we have used in preference to the inlay graft of Albee a type which we designated as the "massive graft", called by Willis Campbell the "onlay graft". It might well be called the "massive onlay graft". In our total of sixty-eight cases of failure, twenty-six grafts were of the massive type, and sixteen were of the inlay type. Since comparatively few inlay grafts have been used, in our experience the percentage of failures is definitely higher with the inlay type. Nine intramedullary grafts were used, and the failures in this group were far too many.

The larger the bone graft (in diameter as well as in length) the better the chance of success. For that reason we have used the term "massive" to drive home that important point. While the large size of the graft is of prime importance, its full benefit will only be attained if broad, firm fixation of the graft against the fragments is provided. Mobility of one end of the graft against the fragment is pretty certain to result in failure of the graft to unite to that fragment. It is needless to emphasize the point that the graft must be long enough to extend well onto the sound healthy bone of each fragment.

### SELECTION OF CASES

Two factors have a bearing on this question: (1) the general condition of the patient, and (2) the local condition at the site of fracture.

The further below puberty the patient's age is, the greater the chance of failure in bone-grafting operations for ununited fractures. In cases of congenital ununited fractures of the tibia in which several operations have failed, it is usually wise to carry the patients on beyond puberty before any further attempt is made, maintaining length and line as nearly as possible by the aid of braces. Our experience with bone grafts from other individuals, even though the blood grouping is satisfactory, has not been a happy one, although we have had a few successes. Elderly people are good subjects in so far as the bone-grafting itself is concerned, for fractures heal just as readily in the aged as in the young adult. Old people, however, do not stand the loss of blood as well as young adults and every means should be taken to keep bleeding at a minimum; nor will elderly people stand prolonged procedures, so operations should be planned in detail and executed as expeditiously as possible.

Scar tissue at the site of fracture should be avoided whenever possible by making the incision in sound skin. As has been said, all redness, soreness, and local heat should have been absent for many months (six at least and preferably a year) in those cases in which infection has previously existed.

### OPERATIVE TECHNIQUE

As a result of our twenty-five years' experience in treating ununited fractures by bone grafts, there has gradually been evolved a technique

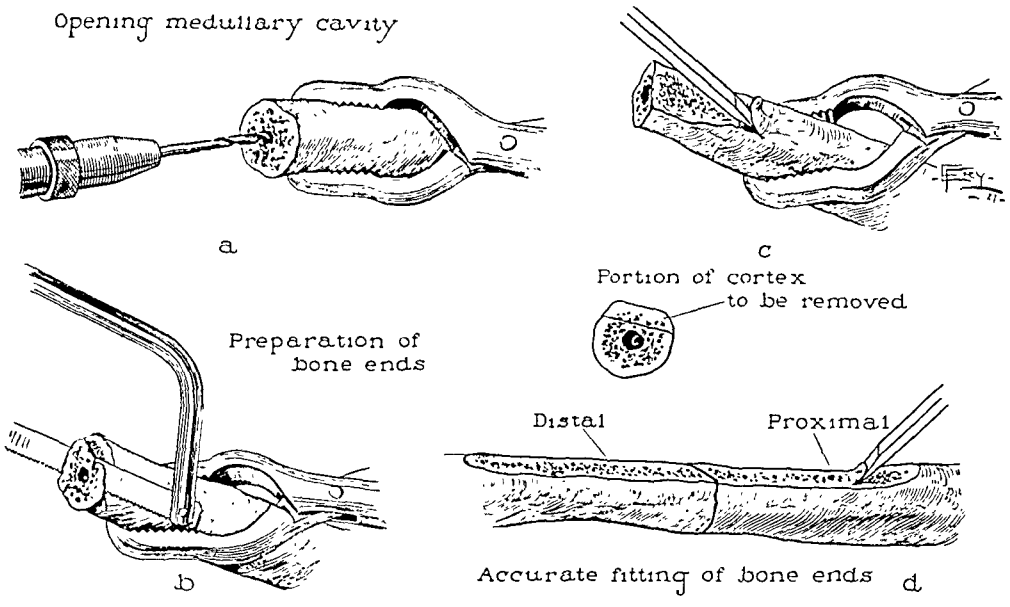



FIG. 1

Preparation of fragments for massive graft: *a*, opening medullary canal with drill; *b*, preparing end of fragment with saw; *c*, preparing cortex with chisel for graft; and *d*, cortex prepared on each fragment and ends freshened and fitted together.

that is giving us a higher percentage of good results than we have ever obtained before. Briefly, it is as follows:

*Anaesthesia*

Spinal anaesthesia for fractures in the lower extremity, with the knowledge and the new drugs now at the command of skilled anaesthetists, is well-nigh ideal. Lacking the services of an anaesthetist skilled in this type of work, the surgeon had better rely on whatever form of anaesthesia he and his anaesthetist are most familiar with.

Brachial block in operations on the upper extremity is so uncertain that it is rarely used at The Mayo Clinic.

Intravenous anaesthesia is being used more and more at The Clinic. Sodium pentothal, for example, can be given for any operation lasting less than an hour but, because it is a respiratory depressant, it should be given only by those skilled in its use and aware of its potential dangers. Postoperative nausea and discomfort are noticeable by their rarity. Its use is contra-indicated, however, in the case of children under ten years of age and in all cases in which dyspnoea is marked.

*Tourniquet*

A tourniquet should be used whenever possible, thus assuring a bloodless field. We prefer the pneumatic type for operations on the upper extremity. The incision must be large enough for adequate exposure of the fragments.

*Exposure of Bone Ends*

In most instances the bone ends must be separated sufficiently to permit dissection of the fibrous tissue from between them; the ends of the bone must be removed and squared off, so that they fit accurately to provide the maximum of contact and still do not shorten the fragments more than is absolutely necessary; and the medullary cavities must be opened. In those cases in which there is no deformity, it may be sufficient to freshen the cortices of the fragments well above and below the fracture site, not disturbing the ends to freshen them or opening the medullary cavity, and to apply a large graft laterally, packing carefully the pieces of spongy bone about the line of fracture.

*Preparation of Fragments for Massive Graft*

The cortices of the fragments must be carefully prepared for the application of the massive graft, to ensure contact of the graft with fresh viable bone. This is best done with a sharp chisel, gently chipping off the bone until bleeding bone is thus exposed. (See Figure 1.)

*Bone Graft*

The bone graft should be long and large. We prefer to obtain it from the flat internal surface of the tibia, as high up as possible in the upper third, for this enables us by aid of a large curette to remove many curettefuls of spongy bone from as near the epiphyseal line as possible where the bone is very active in bone-forming properties. (See Figure 2.) The spongy bone and the irregularities on the medullary surface of the bone graft are removed by the aid of bone biters, thus leaving a smooth surface on the graft for coaptation to the freshened, vascular, cortical surfaces of the fragments. (See Figure 3.)

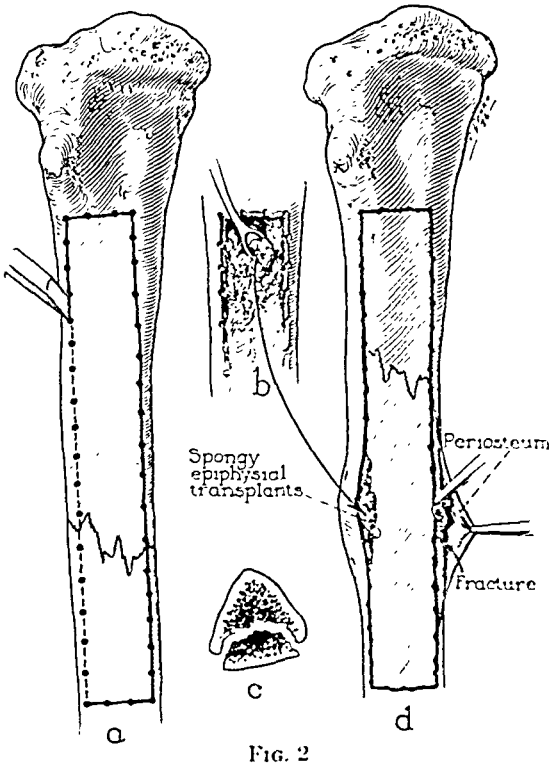



FIG. 2

Bone grafting: *a*, massive graft from flat internal surface of tibia outlined with multiple drill holes and removed by chisel (circular saw on motor may be used, but this is not essential); *b*, spongy bone removed with curette; *c*, cross-section of bone and graft; and *d*, reversible massive graft applicable in tibia; with multiple chips of bone packed about fracture site. (*Courtesy of the Journal of the American Medical Association and of W. B. Saunders Company.*)

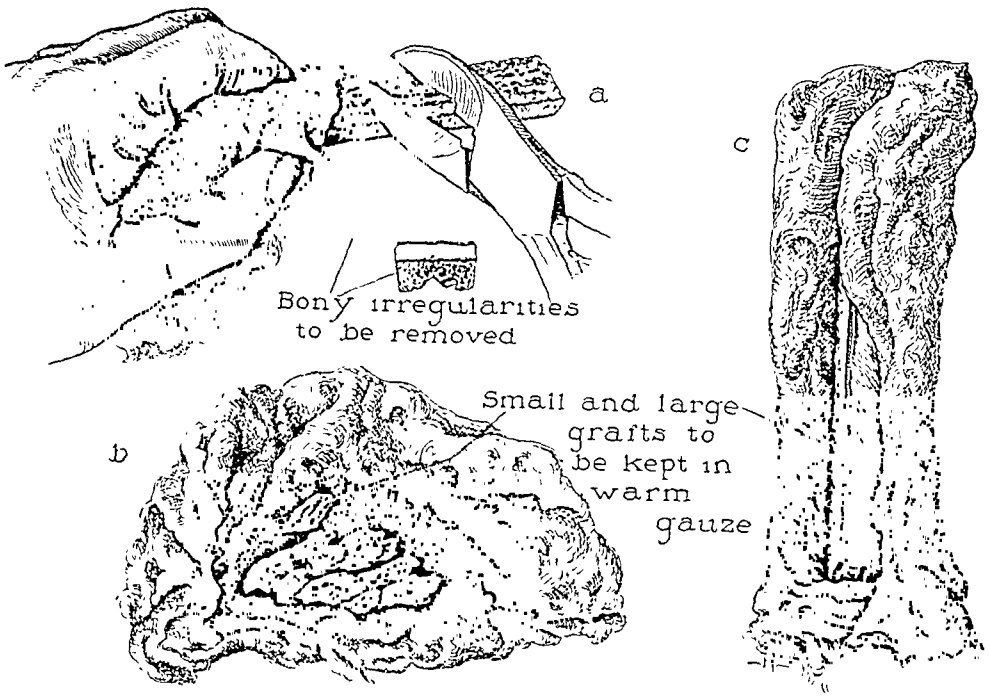



FIG. 3

Bone-grafting: *a*, smoothing down of medullary surface of graft; and *b* and *c*, bone graft and chips of medullary bone kept in moist gauze sponge until time for placing them. (*Courtesy of W. B. Saunders Company.*)

*Fixation of Bone Graft*

The fragments and graft now being ready, the ends of the bones are pressed securely together and the graft is held with the aid of bone forceps firmly against the prepared cortices, and beef-bone screws, two in each fragment, are inserted. (See Figure 4.) These screws hold firmly, are well tolerated by bone, and do not have to be removed. Autogenous bone pegs may be used, but their preparation is a little tedious and another operating team is really necessary, a condition which only seldom can be fulfilled. In osteoporotic bone, so atrophied and soft that beef-bone screws will not hold, we sometimes use Parham bands to hold the graft tightly to the fragments, but these bands should later be removed.

*Bone Chips and Spongy Bone*

The massive bone graft thus fastened holds the fragments nicely in position, and the extremity can be moved without motion at the site of fracture. The scrapings of spongy bone removed from near the upper epiphyseal line and the pieces taken from the medullary surface of the graft should be packed carefully about the line of fracture. This is a most important step and one that has decreased very definitely the convalescent period. It adds bone to the area and, furthermore, spongy bone is especially adaptable to transplantation.

## EXTERNAL FIXATION

Adequate external postoperative support must be provided. Plaster-of-Paris is ideal; there is nothing to equal it. The support must be con-

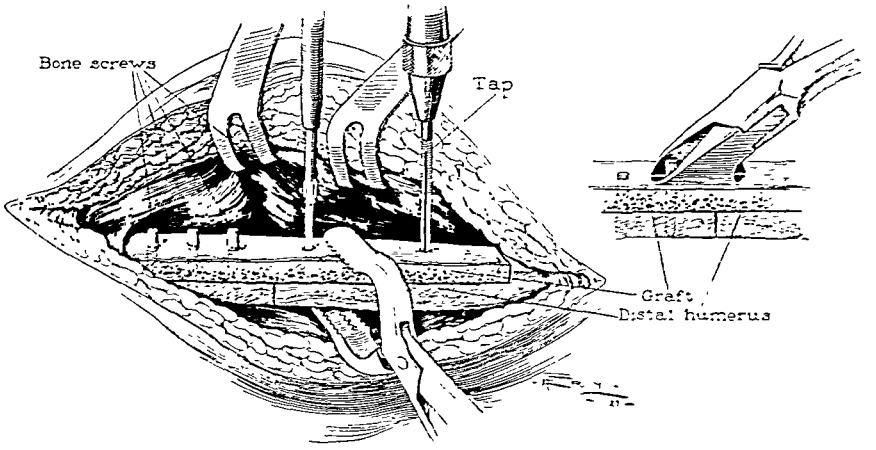



FIG. 4

Fixation of bone graft: The graft is held firmly against surfaces of prepared cortices. Drill holes are made first, then taps are inserted to provide threads in the holes. If this is not done, the beef-bone screws will bind and break when they are screwed in. The hexagonal heads of the bone screws are cut off flush with the graft. (*Courtesy of W. B. Saunders Company.*)

tinued until the fracture is solid. There comes a weak period in any bone graft, about six to eight weeks after insertion, and it is extremely important that external fixation be adequate during that period. Six of our sixty-eight failures were due to disregard of this rule.

### BEGINNING OF FUNCTION

No weight-bearing on the lower extremity should be permitted until roentgenograms show bony trabeculations crossing the fracture line. In fractures of the shaft of the femur a walking caliper splint should be worn until bony union is definite. A lift of several inches on the sound shoe and crutches are advisable also. Active movements should be started as soon as it is safe. In the case of fractures in the upper extremity, the time for the institution of movement varies with the individual case; movement must not be permitted until the surgeon is convinced that union has occurred. The entire course must be supervised and controlled by frequent roentgenographic examinations, because this is the one means by which the surgeon can obtain accurate information as to what is going on at the site of fracture.

# THE USE OF MULTIPLE SMALL BONE TRANSPLANTS IN THE TREATMENT OF PSEUDARTHROSIS OF THE TIBIA OF CONGENITAL ORIGIN OR FOLLOWING OSTEOTOMY FOR THE CORRECTION OF CONGENITAL DEFORMITY

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*From the New York Orthopaedic Dispensary and Hospital*

Of all non-unions of bone, those occurring congenitally in the lower tibia or following osteotomy for the correction of congenital deformity in the same region have been the most difficult to repair.

The reasons for this are not clear, as these defects usually differ in no way from those that are sometimes seen following fractures in the adult, or from pseudarthroses occurring occasionally in the course of a spine fusion, or from a non-union in a subtalar arthrodesis for stabilization of a paralytic foot. In each instance, unless there be interposed muscle tissue, the defect consists of fibrous tissue lying between bone ends that show no evidence of reparative growth and that are frequently eburnated. The fragments may be blunt or narrow and tapering with pointed ends. Circulation is at a minimum, and the marrow cavities are often blocked off by dense sclerotic bone. Microscopically, the bone appears dense and often stains irregularly; the fibrous tissue from the defect is well organized, and shows many fibers and flattened cells and sometimes areas of fibrocartilage.

The lower third of the tibia is notorious for the occurrence of non-union. While this is serious enough in the adult, non-union congenitally or in association with the correction of congenital deformity is doubly so. The poor results of treatment in the congenital cases have been universally commented upon, and reported series of cases have not been encouraging.

The subject of non-union, as well as of the growth of bone, has engaged the attention of clinicians and laboratory men for years. According to Murray, from the lack of change in the normal blood-calcium and phosphorus levels in cases with non-union of fractures, from the absence of demonstrable benefit in such cases from treatment designed to affect the body chemistry, and from the fact that fractures heal in the presence of severe disturbances of bone metabolism (as in osteitis fibrosa or Paget's disease), and in the face of negative calcium balances (as in osteomalacia), it would seem that non-union is a local phenomenon, dependent upon local conditions.

Modern ideas of bone growth have been most clearly expressed by Murray, who has stated that in order for bone to form anywhere in the adult body there must be:

1. Death of tissue;
2. Granulation-tissue growth;

3. A local concentration and supply of calcium;
4. A proper quantitative and qualitative status of the blood and lymphatic circulation.

Death of tissue initiates the process of repair. Granulation tissue springs from the traumatized soft parts of the bone—periosteum, endosteum, and the areolar tissue about blood vessels—and from the surrounding soft tissues at the periphery. It is then calcified, possibly as a result of enzyme activity, from a local concentration of calcium probably derived from the injured bone ends by decalcification. The osseous tissue is first laid down in the relatively avascular areas about the blood vessels, and, at a later date, these areas become almost completely replaced by newly formed bone. A proper blood and lymphatic circulation is necessary for this process to proceed normally to completion. It must be not only adequate in volume and rate of flow, but also satisfactory in qualitative properties such as oxygen content, calcium percentage, and hydrogen-ion concentration.

In the transplantation of bone, it has been established, notably by the work of Bancroft and Ely, that the graft dies and serves merely as a local source of calcium and a framework for the growth of reparative tissue and the formation of new bone. The transplant becomes decalcified, and granulation tissue and blood vessels grow into the haversian canals. Calcification and ossification ensue, beginning in the more avascular areas about the blood vessels. This process has been aptly termed "creeping replacement", and in this way the whole graft eventually becomes changed into new bone. The smaller the transplant, the more quickly will its replacement be effected; the larger the graft, the more will its metamorphosis be delayed and the longer will it be in a physically weakened state and subject to fracture. In this fact, lies the weakness of the massive graft and the superiority of the small transplant.

In the past, two methods of repair have been chiefly used in the treatment of any pseudarthrosis,—the open reduction and the massive graft. These measures have often been ineffective, especially in the cases of congenital origin and in patients under the age of twelve. Healing of the pseudarthrosis has not always followed open reduction; and massive grafts, even after union to the fragments, have fractured months later, resulting in a persistence of the original condition of non-union.

When, as in open reduction, sclerosed bone ends are merely exposed and freshened or resected, the prospect for adequate reparative growth of the granulation tissue is poor, because, in only reflecting dense scar tissue and opening into the sclerosed or eburnated bone, relatively few cells are killed and few soft-tissue spaces of the bone are uncovered and traumatized. Cellular elements are distinctly in the minority in this type of tissue. Massive grafts, because of their large size, require many months for complete metamorphosis into new, living bone. They are, therefore, weak and vulnerable to fracture for a long period of time.

To obviate these difficulties and to base practice rationally on modern

conceptions of bone transplantation and growth, the following operative procedure (Figs. 2 and 3) was devised and applied to those pseudarthroses of congenital nature that have always been so difficult to repair.

## OPERATIVE TECHNIQUE

The area of pseudarthrosis is exposed by a subperiosteal dissection that should be no more extensive than is necessary, so that circulation to the bone will not be unnecessarily compromised. The bone ends are freshened or resected in sufficient amount to correct existing deformity and are placed in end-to-end contact if possible. A broad, shallow, longitudinal groove is fashioned in both fragments, extending from good bone in the upper fragment to good bone in the lower. This groove opens into the marrow cavities and provides a wide area of traumatized bone for stimulation of granulation-tissue growth and for contact with multiple grafts. The groove is then filled with many small bone transplants or chips taken from the opposite tibia or preferably from the ilium. The periosteum is closed with interrupted sutures so spaced as to leave intervening gaps through which blood vessels and granulation tissue can grow into the area of bone formation from the traumatized soft tissues at the periphery. The wound is sutured in layers. Dressings and a plaster cast are applied. The procedure is best carried out under tourniquet conditions.

Walking in plaster is usually allowed ten or twelve weeks after operation, at which time the cast is first changed. Plaster immobilization is maintained until in the roentgenogram the newly formed bone appears strong enough to function without support.

By this procedure, adequate reparative growth of the granulation tissue is promoted, and the ununited fragments are brought into extensive contact through the medium of many small bone masses which will quickly and readily become decalcified and rehabilitated.

Multiple bone transplants have for years been used in the Hibbs spine-fusion operation to obtain bone growth from one lamina to another. Strong areas of bone formation, which are able to withstand the tremendous deforming forces of corrected lateral curvatures or to hold in check the collapsing vertebrae in Pott's disease, regularly result. Macewen has reported bone growth from bone fragments, and Finney, at Johns Hopkins University School of Medicine, has employed this type of transplantation in ununited fractures of long bones. Bancroft, working in the Department of Surgical Pathology of the College of Physicians and Surgeons, Columbia University, quite regularly obtained excellent healing of experimental defects in the radii of dogs by the use of autogenous small bone transplants.

## RESULTS

Five patients have been operated upon by this method at the New York Orthopaedic Dispensary and Hospital from October 1930 to Decem-

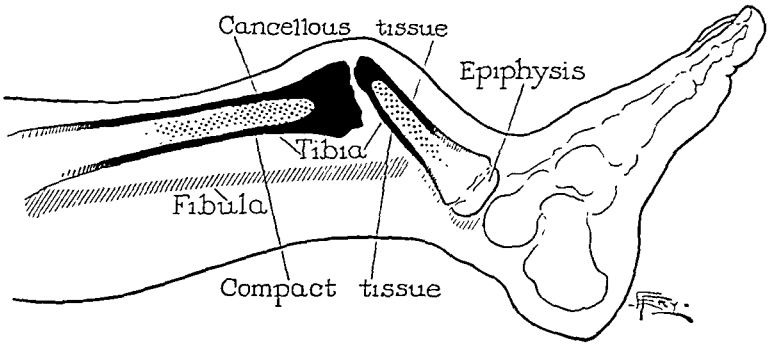



FIG. 1

Drawing showing the preoperative condition.

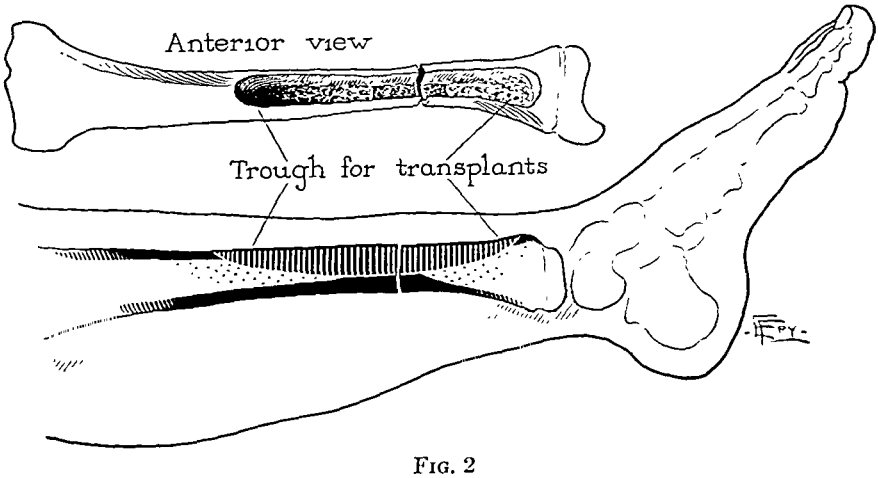



FIG. 2

Drawing showing the technique of the operation. The bones have been resected and aligned. The groove or trough for the multiple small bone transplants extends from good bone proximally to good bone distally.

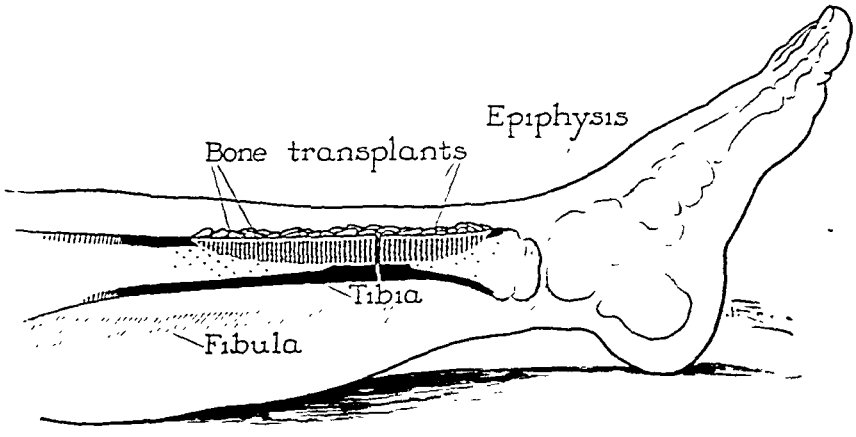



FIG. 3

Drawing showing the technique of the operation. The trough has been filled with numerous small bone transplants obtained either from the ilium or from the tibia.

# A HISTOPATHOLOGICAL STUDY OF THE SYNOVIAL MEMBRANE WITH MUCICARMINE STAINING *

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The recent revival of interest in arthritis and related diseases of joints has placed the cytology and physiology of the synovial membrane once more on a plane of clinical as well as academic importance. According to the American Committee for the Control of Rheumatism [9], "a full understanding of the pathogenesis and treatment of diseased joints must be based on a comprehensive knowledge of the physiology of the joints . . . information on this subject is meager, and only a few workers seem to be putting first things first, going back to essentials". We, therefore, feel somewhat justified in reporting our interpretations of this study. Because of the presence of mucoprotein in normal human synovial fluid [1, 5], an adequate explanation of the sources of these substances will in part, at least, explain the source of the synovial fluid itself and just what rôle the synovial cells play in its production.

The true character of the synovial cells and the mechanism of the production of the synovial fluid are subjects of an ancient controversy. Winslow, in 1753, expressed the opinion that the synovial membrane was composed of glandular epithelial cells and that the joint fluid was a true secretion of these cells. Von Kölliker and Soubbotine later upheld this view; however, the latter worker claimed that he could demonstrate true goblet cells in the membrane, which he held responsible for the secretion of the fluid. Havers thought that the synovial adipose tissue was mucin-producing glandular tissue. Mayeda, among modern investigators, adhered to Winslow's original view.

Bichat, in 1806, said that the synovial membrane was composed of serosal cells, similiar to those lining the pleura, and that the joint fluid was a transudate. This theory later was partially upheld by Todd and Bowmann who also expressed the opinion that the fluid was merely a physiological transudate derived from blood vessels underlying the synovial membrane. Although expressing no definite view as to the nature of the synovial cells, Bauer, Bennett, and Short, in 1933, termed the fluid a simple diffusate derived both from the blood and from the lymph vessels. They based their hypothesis on an important physiological chemical fact,—namely, that the non-electrolyte urea is of the same concentration in the synovial fluid as in the arterial serum.

His and others have maintained that the synovial membrane is of

* Received for publication on July 2, 1937.



FIG. 4-A

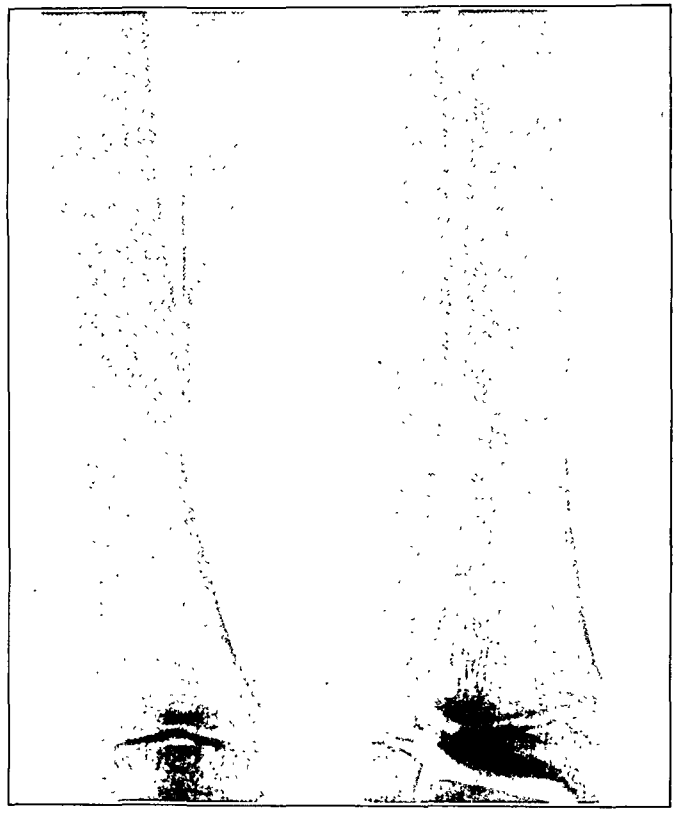


FIG. 4-B

Case 1. G. R., four and one-half years old.
Fig. 4-A: Before multiple-bone-transplant operation on the tibia. The defect in the fibula was repaired seven months later.
Fig. 4-B: Five and one-half years after operation on the tibia and five years after operation on the fibula.

ber 1935. Three had congenital pseudarthrosis of the tibia; two of these had non-union of the fibula as well. Two had failure of union following osteotomy for the correction of congenital deformity. In one patient, while under convalescent treatment at the Country Branch following operation, a second pseudarthrosis developed just above the first.

Seven primary and four secondary multiple-bone-transplant operations have been performed for seven pseudarthroses. In three of the secondary operations, in addition to the chips, a large graft was used chiefly for immobilization purposes.

Of the seven primary operations, four (57 per cent.) succeeded and three (43 per cent.) failed. In one of the three cases of failure, reoperation by essentially the same method (chips laid along the bone, but without the formation of a groove) was successful. In the second case, reoperation (chips and inlay graft) failed. In the third, implantation of a heterogenous graft and chips from the mother also failed to effect union; this case was complicated by suppuration. The patient in the second case has been operated upon a third time, and successful healing has been obtained. At this operation, a long bone graft was wedged between the longitudinally split and overriding fragments and the interstices were filled with a large number of bone chips. This type of graft procedure was suggested by Dr. William Darrach of the College of Physicians and Surgeons, Columbia University, as a method of massive-graft implantation that would least disturb the circulation of the bone, as the periosteum is not reflected, but is merely split with the bone in the preparation of the bed for the graft.

In the successful cases, strong safe healing with roentgenographically normal appearing bone has been relatively quickly obtained.

## CASE REPORTS

CASE 1. G. R., a boy, four and one-half years of age, was admitted to the New York Orthopaedic Dispensary and Hospital on June 17, 1931, for the repair of congenital pseudarthroses of the right tibia and fibula. Two weeks after birth, a swelling had been noticed above the ankle, and a closed reduction was done. Later an open operation had been performed, followed by casts and braces for two years. Non-union had resulted.

The general physical examination was negative. In the lower portion of the right leg there was a 90-degree anterior and a 10-degree lateral angulation of the bones, associated with 10 degrees of motion at the apex. The leg was one and one-half inches short.

Roentgenographic examination revealed a pseudarthrosis of the right tibia at the junction of the middle and lower thirds, with marked anterior and lateral angulation of the fragments. The end of the distal fragment showed condensation, and the proximal fragment was eburnated for a distance of one-half an inch. A similar non-union of the fibula was present in its lower portion.

*Repair of the Tibial Pseudarthrosis*

The multiple-bone-transplant operation, as previously described, was performed on June 24, 1931. An area of non-union, which permitted several degrees of motion, was found in the lower tibia, associated with marked deformity as indicated in the roentgenogram. The defect was filled with dense fibrous tissue, and the bone ends were extremely hard and eburnated. A similar defect was present in the fibula at a little lower level.

been used at the operative procedure. A transfusion was given, with relief. The wound healed without complication, and the plaster was changed and the skin sutures were removed at the end of two weeks. The postoperative roentgenogram showed the bones to be in good alignment and contact. A large number of small chips made excellent contact across the defect with two inches of the proximal and one and one-half inches of the distal fragment. The ankle was in valgus. The pathological report was "rarifying osteitis with fibrosis". Three months after operation, on January 17, 1931, a cast for walking was applied. No motion was found, and the roentgenogram demonstrated almost complete union. All support was discarded at the end of four months and the roentgenogram revealed complete union.

At follow-up examination on October 1, 1932, two years after operation, the patient had no complaints and no limitation of activity. The left tibia was solidly united, and the ankle and foot were in valgus. Roentgenographic examination showed complete union and almost complete restoration of the marrow cavity.

CASE 3. M. E., a girl, two and one-half years of age, was admitted to the New York Orthopaedic Dispensary and Hospital in April 1930, for the correction of a congenital deformity of the right tibia which was thought to have resulted from a malunion following an intra-uterine fracture. The roentgenogram showed a marked anterior and lateral angulation at the junction of the middle and lower thirds, associated with narrowing of the bone, increased posterior cortical development, and constriction of the medullary canal. The deformity was corrected on July 25, 1930, by osteotomy with multiple linear cuts and greenstick fracture. Non-union occurred. An unsuccessful attempt at repair by open reduction, with bone chips placed at the site of non-union, was done on September 15, 1930. Nineteen months later, the roentgenogram revealed non-union at the junction of the middle and lower thirds in both the right tibia and fibula. The bones were angulated anteriorly 45 degrees. The end of the distal tibial fragment was pointed, but not eburnated. The cortex of the proximal fragment showed increased density for one-half an inch, and the marrow cavity was obliterated for one-quarter and narrowed for three-eighths of an inch.

*Operation 1*

The multiple-bone-transplant operation, as previously described, and lengthening of the calcaneal tendon, to aid in correction of the deformity, were done on April 9, 1932. The fragments were angulated, and the defect was filled with fibrous tissue. The proximal fragment was narrowed for a distance of one and one-half inches and was eburnated and hypovascular. The marrow cavity terminated three-quarters of an inch from the end. The distal fragment was eburnated for three-eighths of an inch.

Two weeks after operation, the cast was changed and a remaining 20-degree angulation was corrected without force. The postoperative roentgenogram showed the bones to be in contact, but the distal fragment was subluxated medially almost the width of the proximal one. Many bone chips covered two and one-half inches of the shaft above and one and one-half inches below, but appeared scant at the level of the pseudarthrosis.

Two and one-half months after operation, motion was present and the roentgenogram showed non-union. Plaster support was continued, but walking was not allowed. One and one-half months later, the patient was admitted for reoperation.

*Operation 2*

Multiple onlay bone chips were transplanted on August 9, 1932. No groove was made, and long slender chips were placed closely and with overlapping to bridge both areas of non-union. An oblique pseudarthrosis was found between pointed bone ends, and two inches above there was a second pseudarthrosis traversed by firm fibrous tissue. The bone was covered with moderately vascular scar tissue and possessed a fairly good blood supply; but it was decalcified distally.

The postoperative roentgenogram showed good alignment, but the bone ends were

The wound healed well, and there were no complications. The postoperative roentgenograms showed the fragments to be in excellent alignment and the bone ends in contact. Numerous bone chips made good contact with one and one-half inches of the upper and one inch of the lower fragment, and extended above and below into areas of normal appearing bone. Ten weeks after operation, union was present, and a cast for walking was applied. The roentgenogram showed the presence of union through the medium of confluent chips, and beginning union of the bone ends. Plaster support was discontinued at the end of six months, at which time union was firm clinically and roentgenographically.

On January 9, 1937, five and one-half years after operation, union was firm clinically and roentgenographically. The patient walked without a limp. There was one and five-eighths inches of shortening of the right tibia.

*Repair of the Fibular Pseudarthrosis*

On January 25, 1932, seven months after the operation on the tibia, the fibular pseudarthrosis was similarly repaired. On account of the small size of the upper fragment, it was impossible to make a satisfactory groove; therefore, this fragment was split longitudinally, the edges were held apart, and the intervening space was filled with bone chips which were continued down onto the lower fragment in a groove. Roentgenographic examination, two months after operation, showed excellent bone development from the mass of chips and partial union of the bone ends. Plaster support was discontinued four months after operation, at which time the roentgenogram revealed complete union.

On January 9, 1937, five years after the fibular repair, union was present clinically and roentgenographically.

CASE 2. L. C., a girl of nine, was admitted to the New York Orthopaedic Dispensary and Hospital on August 15, 1927, complaining of congenital deformity of the left leg.

On examination, marked anterior bowing of the lower leg was found. The roentgenograms showed a pronounced anterior bowing in the middle and lower thirds of the tibia and an ununited fracture of the lower third of the fibula. On October 31, 1927, the deformity was corrected by an osteotomy. This was followed by non-union, for the repair of which the following unsuccessful operations were performed:

1. Sliding graft and bone chips, March 28, 1928;
2. Open reduction and bone chips, December 13, 1929;
3. Onlay graft and bone chips, February 24, 1930.

The chips used in each instance were small in number and for the most part were placed only about the pseudarthrosis.

The patient was readmitted on October 7, 1930, at the age of twelve. There was a fusiform enlargement of the left tibia at the junction of the middle and lower thirds with motion at this point in all directions. The left leg was two inches short. General physical examination was negative, and the Wassermann test was also negative. In the roentgenogram there was an area of non-union in both the tibia and the fibula. The bone ends were in contact, and the distal fragment of the tibia was deviated medially 20 degrees. Condensation of bone was present in both fragments. This extended for about one inch in the upper fragment and obliterated the medullary cavity for the same distance.

The multiple-bone-transplant operation, as previously described, was performed on October 13, 1930. The graft that had been used at the last previous operation, eight months before, was united at both ends, but through the center there was an area of non-union. This defect was filled with fibrous tissue, and there was no evidence of callus formation. The bone on both sides of the pseudarthrosis appeared to be sclerotic and hypovascular.

Severe shock followed the operation, because of loss of blood. A tourniquet had not

FIG. 5-C



FIG. 5-D

FIG. 5-C: Six months after operation.
FIG. 5-D: Three years after operation. Good union has been obtained.

FIG. 5-A



FIG. 5-B

Case 4. M. T., four and one-half years old.
Fig. 5-A: Before multiple-bone-transplant operation.
Fig. 5-B: Immediately after operation. The mass of small bone transplants extends from good bone proximally to good bone distally.

then allowed to walk with the leg in plaster. Both grafts underwent irregular absorption. One fractured in two places before the end of three months, and the other fractured during the fourth month. Two of these fractures, one in either graft, healed and one did not. Later, another fracture occurred just below a healed one, and non-union was the result.

Thirteen months after operation, at the age of four and one-half years, the patient was readmitted. The right tibia was enlarged in the lower portion, which showed a little anteromedial deviation. Slight motion was present at this point. The leg was one and one-quarter inches short. The general physical examination was negative, and the Wassermann test was also negative. The roentgenogram showed an area of non-union at the junction of the middle and lower thirds, with one inch of eburnated bone in either fragment.

The multiple-bone-transplant operation, as previously described, was performed on January 18, 1932. The bone ends were hard and the distal one was eburnated. The marrow cavity of the proximal fragment extended to within three-quarters of an inch of the line of non-union, and that of the distal to within one-half an inch. Deformity was not marked, the general alignment of the leg was good, and no attempt at correction was made. The defect was filled with fibrous tissue.

No complications developed, except a stitch abscess which healed readily. The plaster was changed and the sutures were removed on the sixteenth day. The postoperative roentgenogram showed multiple bone chips that made excellent contact over a large area from good bone above to good bone below. Microscopic study of material removed at operation showed fibrous tissue and fibrocartilage.

On March 15, 1932, two months after operation, union was present and was corroborated roentgenographically. Walking in a plaster cast was allowed. At the end of four months, all support was discarded, and the roentgenogram showed further progression toward complete union. At the end of six months, union was complete.

On January 5, 1935, three years after operation, union was solid in good alignment. The patient walked well and had no limp or pain. Measurements revealed one inch of shortening in the right leg.

CASE 5. M. P., a colored girl, aged three, was admitted to the New York Orthopaedic Dispensary and Hospital on January 7, 1933, for repair of a congenital pseudarthrosis of the left tibia and fibula. She had had no previous treatment except for rickets. A false point of motion and a marked anterior angulation in the lower leg were noted. Measurements were not recorded, as it was impossible to obtain accurate ones because of the marked deformity. The roentgenogram showed an area of non-union at the junction of the middle and lower thirds of both the left tibia and fibula, with a 90-degree anterior angulation. The tibial fragments were tapering and narrow. The distal tibial fragment and both fibular fragments were eburnated.

*Operation 1*

Lengthening of the calcaneal tendon was done on January 23, 1933. The deformity was corrected to a 65-degree angulation.

*Operation 2*

The multiple-bone-transplant operation, as previously described, was performed on February 21, 1933. A 90-degree anterior angulation with pseudarthrosis was found. The bone ends were separated one-eighth of an inch by dense fibrous tissue and were eburnated and avascular for a distance of one-quarter of an inch. A similar narrow pseudarthrosis was found in the fibula.

The wound healed well, and there were no complications. Microscopic study of tissue removed at operation showed cellular connective tissue, absence of bone formation, and poorly staining but relatively normal bone. The postoperative roentgenogram revealed a gap of three-eighths of an inch between the tibial fragments. Numerous small bone chips, scant at the line of pseudarthrosis, made good contact with the tibial frag-

not quite in contact. A transverse pseudarthrosis was present in the tibia, one inch above the original one. Numerous bone shavings bridged both pseudarthroses, extending one inch above the upper one but not quite into good bone, and three-quarters of an inch below the lower one just to good bone.

The lower pseudarthrosis healed, but the upper one did not, and, on November 14, 1933, fifteen months after the last operation, motion was still present in the lower tibia. The roentgenogram demonstrated failure of union of the upper pseudarthrosis, and good union of the lower and original one, with confluent bone of increased density, but without a medullary canal.

*Operation 3*

The multiple-bone-transplant operation, as previously described, and transplantation of an inlay bone graft from the opposite tibia were done on December 11, 1933. The periosteum was scarred and adherent about the pseudarthrosis which was filled with a dense scar. The bone was compact, and the marrow cavity ended about one and one-quarter inches from the defect.

The postoperative roentgenogram showed the graft and fragments to be well apposed in good alignment. However, failure of union occurred.

*Operation 4*

Repair of non-union by open reduction with overriding of fragments, multiple bone chips, and a tibial bone graft, as described in the next paragraph, was done on November 27, 1935. A pseudarthrosis was found at the junction of the middle and lower thirds of the right tibia. Anterior and medial angulation was present with the distal fragment overriding the anterior aspect of the proximal fragment. The ends of the fragments were sclerosed, and the marrow cavity was obliterated about three-fourths of an inch from either end. The defect was filled with tough fibrocartilaginous tissue.

*Procedure:* The scar tissue in the pseudarthrosis was divided transversely, and the bone ends were freshened. The periosteum was reflected only on the anterior surface of the distal and on the posterior surface of the proximal fragment. Both fragments were then longitudinally split, the cleft reaching high up into normal bone and low down into healthy appearing bone. The fragments were then reduced and the distal fragment was made to override the proximal, but on its posterior aspect. This allowed contact of the most healthy appearing portions of the fragments. The longitudinally divided fragments were then spread apart and a bone graft (five inches by three-eighths of an inch by one-eighth of an inch), cut from the opposite tibia, was inserted in the clefts and sutured in place with 40-day chromic catgut. A large number of bone chips, also taken from the opposite tibia, were distributed throughout the operative area in the bone. The wound was closed in layers, and a plaster cast was applied.

The postoperative roentgenogram showed excellent apposition of the fragments, graft, and chips. Microscopic examination of the tissues removed from the pseudarthrosis showed fibrous, fibrocartilaginous, and bony tissue. Evidence of a little bone formation and bone absorption was seen.

At the end of three months, on February 18, 1936, light union was present roentgenographically, and only a little springy motion was demonstrated clinically. On April 14, 1936, a little less than five months after operation, union was solid, and the patient was allowed to walk in plaster. The cast was removed two months later, and the patient was discharged from the Hospital on August 8. She was last seen in November 1937. Union was present clinically and roentgenographically.

CASE 4. M. T., a girl, three and one-half years of age, was admitted to the New York Orthopaedic Dispensary and Hospital on November 24, 1930, for the repair of a non-union of the right tibia, which was first noticed eight days after birth. A closed reduction and then an open reduction were done early in life without success. On December 5, 1930, two onlay grafts were laid across the defect, and bone chips were placed about them. A cast was applied, and the child was kept in bed for three months, and

endothelial character and that it is a developmental derivative of the second embryonic layer.

Frerichs was able to demonstrate the presence of mucin in the synovial fluid as early as 1846. On the basis of this finding, he concluded that the synovial fluid was a product of mucoid degeneration. It was held that this degeneration was favored by the grinding motion of the joints. Following this important contribution to the subject, Hueter, Hagen-Torn, Hammar, and others emphatically declared that the synovial cells were of connective-tissue origin. Müller, in 1929, adhered to the cellular-disintegration theory of Frerichs, and accepted a connective-tissue origin of the cells.

In 1931, King investigated the synovial fluid from the standpoint of viscosity and colloidal phenomena and was able to extract the mucinous substances. He also made a study of the cells by means of special stains. He concluded that "the structure and function of the synovial membrane are twofold: a connective capsule for binding purposes in which secretory elements are interposed". Jones, in a more recent work, showed that the viscosity of the synovial fluid of animals is due to the presence of mucin, and that, when this substance is removed, the viscosity is no more than that of a simple exudate.

Vaubel, in 1933, made a study of the cells by means of tissue cultures. He was able to demonstrate vacuoles of mucin in the living cells. He also noted chemically the presence of mucin in the blood plasma in which the cells were grown. He concluded that the mucin was a product of a special synovial cell which he designated a "synovioblast". He did not believe that the synovial fluid was a true secretion, but felt that the "synovioblasts" had properties which were similar to those of the so-called chondroblasts of cartilaginous tissue. In the latter, the connecting matrix is held to be a product of the chondroblasts. In contradistinction to Frerichs and Müller, he further held that the mucoproteins were not products of degenerating cells, but resulted from the normal activity of healthy, living cells. This last view has been upheld by King in a recent work on the Golgi apparatus of the synovial cells. It is thought that when the granules of Golgi can be demonstrated in a connective-tissue cell, the cell is alive and carrying out the normal metabolism of a living-cell unit. King found that this structure became enlarged in conditions in which there was an increased production of the synovial fluid. He was also able to show a well-formed Golgi apparatus in synovial cells which were lying free in the joint fluid.

Among the bizarre theories concerning the production of the synovial fluid is that of Banchi who claimed that the joint fluid was formed from the articular cartilage and not from the synovial membrane.

## HISTOLOGICAL MATERIAL, METHODS, AND FINDINGS

We have attempted to show the source of mucoproteins in the synovial fluid by means of properly prepared human tissues which were stained

ments for one inch above and three-quarters of an inch below the line of non-union, and extended well into good bone.

Two and one-half months after operation the plaster was removed. Motion was present, and the roentgenogram showed that all the bone chips had disappeared, except for a group at the proximal fragment, which had formed a mass of bone, attached to the shaft. There was a gap of three-eighths of an inch and the distal fragment had become posteriorly displaced upon the upper one.

On June 16, 1933, four months after operation, the fibrous tissue was removed from between the bone ends, and the eburnated bone was resected. An onlay graft was taken from the mother's tibia and was laid across the defect in the patient's tibia. The space between the bone ends was filled with chips also from the mother's tibia. Infection developed, sequestration of the graft occurred, and non-union resulted. The leg is at present (1937) in a brace, and repair will be attempted when the child is older.

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# MYOSITIS OSSIFICANS

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The clinical and pathological data on twenty-five cases of myositis ossificans collected in the Surgical Pathological Laboratory of the Johns Hopkins Hospital and University are reviewed in this paper. The series includes both the circumscribed and the progressive forms.

The circumscribed form has been subdivided into several types by various authors, but we are inclined to accept only the clinical varieties of traumatic and non-traumatic myositis ossificans. Trauma is the most common cause of muscle ossification. Fifteen cases, or 60 per cent., of the present series had a definite history of injury. The lesion may follow a single mild or severe blow. Dislocations or fracture-dislocations, especially of the elbow, may give rise to these pathological changes. This series included one instance of fracture, but no dislocations. In the older literature, ossification is often described as occurring in the thigh muscles of shoemakers, or in the "rifle shoulders" of infantry men, or in the thighs of cavalry men (so-called "rider's bone"). Occupation played no rôle in any case of this series. The thigh was involved in fourteen instances; the arm, in three; the elbow, in two; the neck and the lumbar muscles, once each. The age of onset varied from thirteen to seventy-two years. Sex appeared to be an outstanding factor and is probably explainable on the basis of activity. In a series of twenty-three cases, there were twenty-one males, one instance in which the sex was unrecorded, and only one female.

Although many cases of myositis ossificans progressiva have been collected in the literature, only two were found in the series of twenty-five cases of muscle ossification. This form, which was first described by Guy Patin in 1692, usually begins in childhood and has a predilection for the muscles of the spine. As the name implies, it is progressive and eventually involves the muscles of the entire skeletal system. Trauma plays an important etiological rôle, but, as is the case with the circumscribed type, the cause is unknown. Both of our cases occurred in females. The first followed a fall at the age of six, and began in the muscles of the neck. The second case, also resulting from an injury, began at the age of ten; the first lesion was in the muscles of the thoracic portion of the spine. In both cases the lesions slowly progressed and became multiple.

The earliest physical finding consists of a doughy mass which gradually becomes indurated. It may make its appearance within a few hours. The earliest evidence of ossification is manifested in the roentgenogram by small, discrete, dense shadows which lie some distance from normal

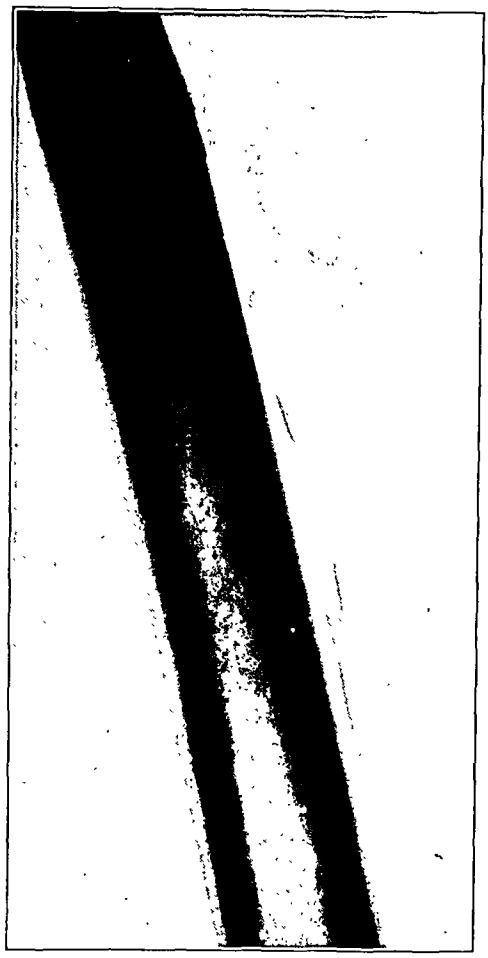


FIG. 1

Early x-ray changes in a case of myositis ossificans, showing dense discrete shadows.

bone (Fig. 1). These areas gradually become confluent and form one large spicule of bone that continues to be separated from the shaft in about three-fifths of the instances (Cahier). Bone can be seen roentgenographically as early as three weeks, and it reaches its maximum growth in from ten weeks to six months (Gruca). Lewis states that bone formation ends within six weeks, and then either regresses or remains stationary. Kienböck, in a roentgenological description of the condition, specifies four weeks as a minimum time in which bone can be detected by x-ray. Bone has been found in abdominal wounds as early as three weeks. One of our recent cases showed calcification of the thigh muscles within nineteen days. The roentgenographic appearance varies. Beginning as the small dense shadows already described, the ossification may assume large proportions and various shapes. The so-called "dotted-veil" appearance seen in the roentgenogram (Fig. 2) has been described by one of the authors as pathognomonic.

The diagnosis is not always simple. Malignancy can often be eliminated only with difficulty. Malignant changes may complicate a benign lesion (Chambers, Coley, Paul). In one instance, myositis ossificans followed operative removal of an exostosis and simulated the cartilaginous cap usually found surmounting an exostosis (Fig. 3). Periosteal ossification resulting from various causes can be eliminated with careful consideration.

## PATHOLOGY

The bone lesion, when exposed at the operating table, is usually surrounded by a gelatinous substance which appears to be the result of muscle degeneration, and the lesion is intimately related to this tissue. Since the bone is often attached to the shaft, it follows that the gelatinous material is then absent in part. Beneath this material a fibrous capsule is usually found, and it is apparently this capsule which is the mother substance of the bone formed in myositis ossificans. Radiating from the capsule are irregularly distributed bands of connective tissue which also invade the bone formation. Cystic changes are occasionally found

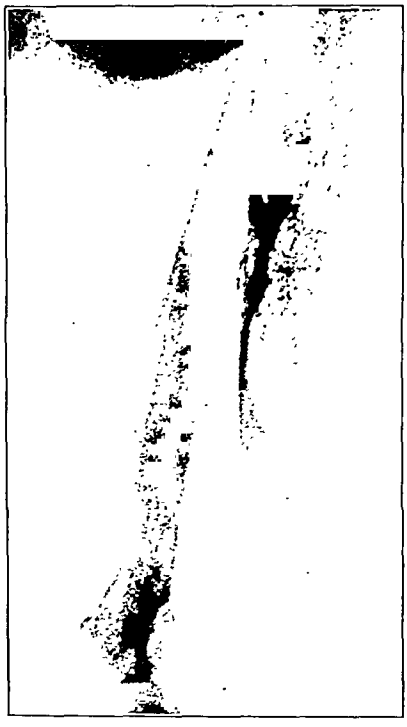


FIG. 2

The so-called "dotted-veil" appearance in an advanced case of myositis ossificans. (*Courtesy of The American Journal of Cancer.*)



FIG. 3

A case of myositis ossificans secondary to operative removal of an exostosis, in which muscle ossification simulated the cartilaginous cap ordinarily found surmounting the spicule.

(Schultz and others). This series includes one case that presented cystic changes and grossly resembled a giant-cell tumor (Fig. 4).

HISTOLOGY

In a study of twenty-five cases, the presence of hemorrhage, the organization of hemorrhage, cartilage, endochondral ossification, periosteal ossification, myxomatous tissue, angiomatous tissue, calcification *en masse*, hyalinization of capillaries, and degeneration of muscles were found. Any group of these may accompany bone formation in a section or group of sections. The authors were impressed by the predominance of a



FIG. 4

A gross specimen of myositis ossificans, presenting cystic changes.

TABLE I

SUMMARY OF CASES OF MYOSITIS OSSIFICANS

| Pathology No. | Age (*Years*) | Race | Sex | History | Physical Examination | Diagnosis |
|---|---|---|---|---|---|---|
| 37312 | 13 | White | Male | Injured thigh falling off bicycle | Mass in thigh | Myositis ossificans traumatica |
| 26712 | | White | Male | Specimen of tissue from an amputated leg sent to this laboratory | Mass in thigh following football injury | Original diagnosis: sarcoma<br>Final diagnosis by our laboratory: myositis ossificans traumatica |
| 10249 | 15 | | | | | Myositis ossificans |
| 36200 | 36 | White | Male | Injured thigh | Mass in thigh | Myositis ossificans traumatica |
| 56333 | 25 | White | Female | Progressive swellings beginning at age of six | Multiple areas of ossification | Myositis ossificans progressiva |
| 22323 | 43 | White | Male | Struck in thigh by flying wheel | Mass in thigh | Myositis ossificans traumatica |
| 43038 | 19 | Colored | Male | Injured thigh playing football | Mass in thigh | Myositis ossificans traumatica |
| 37966 | 27 | White | Male | Recurring attacks of pain in right knee beginning at age of sixteen | Mass in right thigh | Myositis ossificans circumscripta |
| 18584 | | White | Male | Specimen submitted to this laboratory<br>History indefinite | | Myositis ossificans |
| 44802 | 72 | White | Female | Slowly growing mass in neck of one year's duration | Nodular mass in neck | Myositis ossificans? |
| 48662 | 11 | White | Male | Fractured elbow | Mass in anterior and internal portions of elbow | Myositis ossificans traumatica |
| 322 | 30 | White | Male | Injury | Swelling in right thigh | Myositis ossificans traumatica |

TABLE I (*Continued*)

| Pathology No. | Age (*Years*) | Race | Sex | History | Physical Examination | Diagnosis |
|---|---|---|---|---|---|---|
| 56331 | 10 | White | Female | Injury | Multiple areas of ossification | Myositis ossificans progressiva |
| 43672 | 25 | White | Male | History of injury | Mass in thigh | Myositis ossificans traumatica |
| 36014 | 28 | White | Male | Lump in arm, several weeks following sprain of shoulder | Mass in arm above insertion of deltoid muscle | Sarcoma secondary to myositis ossificans traumatica |
| 31538 | 20 | White | Male | Injured arm playing football | Mass in arm | Myositis ossificans traumatica |
| 33534 | 17 | White | Male | Injured thigh<br>Noticed tremor several weeks later | Mass in thigh | Myositis ossificans traumatica |
| 36016 | | White | Male | Swelling in leg following injury | Mass in thigh | Myositis ossificans traumatica |
| ✓ 8610 | 18 | White | Male | Dull pain in lumbar region<br>Noticed lump a month later | Mass in lumbar region | Myositis ossificans circumscripta |
| 10961 | | White | Male | Injury eight weeks previously | Mass in thigh | Myositis ossificans traumatica |
| 6461 | 30 | White | Male | Injured arm falling through hatch | Mass in anterior cubital fossa | Myositis ossificans traumatica |
| 53128 | 46 | White | Male | No injury<br>Pain in both thighs, subsiding in one | Mass arising in one thigh | Myositis ossificans circumscripta |
| 11313 | 28 | White | Male | | Mass in biceps | Myositis ossificans |
| 58176 | 18 | White | Male | Exostosis of femur removed<br>X-ray three months postoperatively showed a myositis ossificans complicating a recurring exostosis | Mass in vastus medialis | Myositis ossificans traumatica |
| 59228 | 13 | White | Male | Trauma eight weeks previously | Mass in right thigh | Myositis ossificans traumatica |

TABLE II

CLASSIFICATION OF MUSCLE OSSIFICATION BY TISSUE CHANGES

| Changes | No. of Cases |
|---|---|
| Typical | 15 |
| Cartilaginous | 5 |
| Angiomatous | 2 |
| Myxomatous | 2 |
| Malignant | 1 |
| Total | 25 |



FIG. 5

Photomicrograph (medium magnification), showing young osteoid tissue surrounded by osteoblasts.

single type of change in a given instance. The cases studied could be grouped by these secondary changes which, with the exception of malignancy, are not dependent upon the types of ossification and vary with the section and stage of ossification. (See Table II.) Although the classification has no apparent clinical value, it is of assistance in the study of muscle ossification.

Degeneration of muscles, hyperplasia of connective tissue, and organization of hemorrhage are the earliest histological manifestations. There



FIG. 6

Photomicrograph (medium magnification), showing collections of colloid material which appears to be a nucleus for bone-spicule formation.



FIG. 7

Photomicrograph (medium magnification) of cartilage in myositis ossificans.

appears to be a tendency to capsule formation, which is almost simultaneous with calcification *en masse* of the inner portion of young connective tissue. Islands of osteoid tissue (Fig. 5) spring up and become invaded and surrounded by osteoblasts. Marrow spaces form, and capillary slits, filled with numerous red cells, appear. Aggregations of small collections of colloidlike material, probably osteomucin, were seen in a few specimens, and they appeared to form a nucleus for future bone spicules (Fig. 6). With advancing bone formation, partially formed osteoid



FIG. 8

Photomicrograph (medium magnification) of bone formation within capillary walls.

spicules are surrounded by numerous osteoblasts. The more completely formed spicules are typical of those seen in the complete process of normal cancellous-bone formation and are surrounded by well-formed osteoblasts with nuclei for the most part eccentrically placed.

The presence of cartilage in ossifying myositis has often been reported. In the pathological material under consideration, cartilage occurred in from 25 to 30 per cent. of the total. Pseudocartilaginous areas are occasionally found, and one then hesitates to accept the presence of

tissue removed at autopsy was replaced by a very cellular stroma with marked tendency to whorl formation. Within the meshes of this tissue were occasional spicules of bone. (See Figure 12.)

## TREATMENT

The analysis of these cases led us to believe that the conservative form of treatment is often preferable to the radical form. Post-operative recurrences are common, especially if surgical removal of the tumor is undertaken before six months, or if resection is not complete. Deep x-ray therapy is being tried in a series of cases. We are unable at this time to evaluate its usage. It must be remembered that ossification occasionally regresses and, when persisting, is not always a functional or painful disturbance.

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# THE DIAGNOSIS AND TREATMENT OF SACRO-ILIAC CONDITIONS BY THE INJECTION OF PROCAINE (NOVOCAIN)

BY KEENE O. HALDEMAN, M.D., AND RALPH SOTO-HALL, M.D., SAN FRANCISCO, CALIFORNIA

*From the Department of Surgery, Division of Orthopaedic Surgery, University of California Medical School*

The confusion which exists among physicians in regard to the diagnosis of and the pathological changes in various conditions attributed to the sacro-iliac joints indicates the need for a more exact diagnostic procedure than is now in common use. Often derangements of the lumbosacral articulations, true sciatic neuritis, or intraspinal lesions are difficult to distinguish from the true sacro-iliac syndrome, because of their somewhat similar neurological and postural manifestations. Although each of these conditions has distinguishing clinical patterns, exact diagnosis is often lacking, and one must resort to radical therapeutic measures without the certainty that benefit will follow. Therapeutic tests, such as traction and body casts, are also helpful, but they are time-consuming and troublesome to the patient. For these reasons, we offer the following routine as an aid in the diagnosis and treatment of conditions attributed to derangement of the sacro-iliac joints.

During the past decade considerable work has been reported on the use of procaine hydrochloride in the treatment of disturbances of various joints. This method of treating sprains of the ankle and of other joints was popularized by Leriche. The value of injections of procaine in the diagnosis and treatment of lesions in the shoulder region has been reported by the authors. In cases of painful coccyx, Mandl obtained a favorable response to the epidural injection of procaine through the sacral hiatus. The method of injection of procaine into the sacro-iliac joint, which forms the basis for the present report, was described by one of us (K. O. H.) in 1936. A somewhat similar procedure in the treatment of backache centering at the thoracolumbar junction was recently discussed by Judovich and Bates. The results of a very painstaking analysis of the differential diagnosis in low-back pain, by means of the injection of a few cubic centimeters of procaine into the tender point in the lower back, were presented by Steindler and Luck before the American Medical Association in June 1937. They did not use this injection for the purpose of treatment, but, rather, to determine the relationship of referred sciatic pain to the tender area in the lower back.

The series presented in this paper consists of forty-two consecutive cases in which a diagnosis of probable chronic sacro-iliac strain had been made. Twenty-four patients in this group also complained of pain along the course of one or of both sciatic nerves. We excluded from this study

by the standard mucicarmine technique of Mayers, originally described in 1896.

We have studied 168 excised specimens of tissue which included all the tissues of the human body in which one normally expects to find synovial membrane. Twenty-five specimens were obtained from synovia of membranes of joints; in eighteen of these there was evidence of chronic non-specific synovitis, and in seven there was tuberculous synovitis. Fourteen specimens were taken from the tenovaginal covering of the



FIG. 1-A

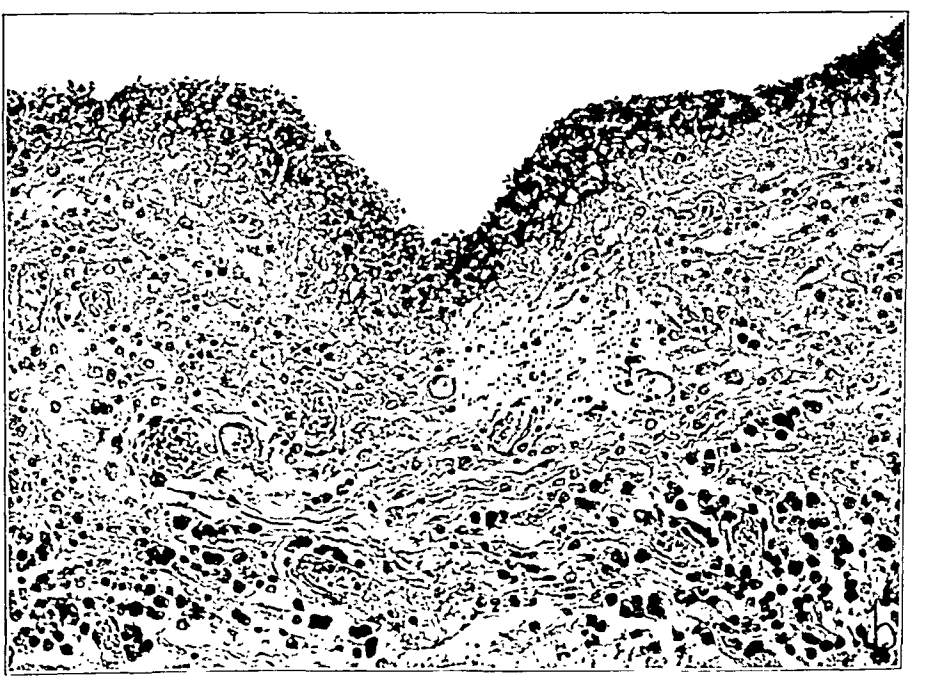


FIG. 1-B

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tissue removed at autopsy was replaced by a very cellular stroma with marked tendency to whorl formation. Within the meshes of this tissue were occasional spicules of bone. (See Figure 12.)

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The analysis of these cases led us to believe that the conservative form of treatment is often preferable to the radical form. Post-operative recurrences are common, especially if surgical removal of the tumor is undertaken before six months, or if resection is not complete. Deep x-ray therapy is being tried in a series of cases. We are unable at this time to evaluate its usage. It must be remembered that ossification occasionally regresses and, when persisting, is not always a functional or painful disturbance.

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of the ilia. (See Figure 1.) The needle is then directed toward the desired side, so as to make an angle of 45 degrees with the skin. At this angle, the needle will pass between the lateral portion of the sacrum and the overhanging posterior superior iliac spine, through the fibers of the interosseous sacro-iliac ligament to the posterior margin of the sacro-iliac joint. The procaine is slowly injected while the needle is being inserted. After encountering bony resistance, the needle is partially withdrawn and reinserted several times, so as to obtain a fan-shaped area of infiltration along the posterior aspect of the sacro-iliac joint. A word of caution seems advisable: The needle should not be inserted at such an angle that it will pass superiorly to the upper margin of the sacrum, as it might cause damage in this region. This approach to the sacro-iliac joint becomes apparent if one studies a mounted skeleton. After waiting five or ten minutes for local anaesthesia to take place, the examiner carries out the manipulation of the sacro-iliac joints. Such manipulations include straight-leg raising, hyperextension of the hip with the knee flexed and the patient in the prone position, sudden traction on one leg while the other is fixed, and the method whereby one shoulder is pressed against the table and the pelvis on the same side is rotated forward as far as possible, the patient being in the supine position. It is usually found that straight-leg raising, which is limited and painful before injection, becomes normal or much improved under local anaesthesia. Likewise the patient can flex the spine forward much farther after the injection. The lower back is then strapped with adhesive tape, and the patient is instructed to report in a few days. In a few cases there was an exacerbation of sciatic pain for a day or two following the manipulation, and an analgesic was required. In a few instances in which relief was transitory, the injection of procaine was repeated after one week, usually with additional improvement.

## RESULTS

The records of forty-two patients here reported were studied and tabulated as to symptoms, signs, roentgenographic findings, treatment, and results. These tables were condensed for publication, with special attention to the results of the injection of procaine (Table I), and the tabulation was further condensed to show end results (Table II). It is unfortunate that a final examination could not have been recorded for every patient, but many of them were seen in a clinic and the records were incomplete.

## DISCUSSION

From the results obtained in this series of cases, it would appear that the local injection of procaine in patients presenting the clinical picture of chronic sacro-iliac derangement causes an immediate transient disappearance of signs and symptoms in most of these cases, and, in a fairly large proportion of instances, the relief obtained is more lasting. The immediate improvement in symptoms we attribute to the injection itself. In the large majority of cases in which manipulation also was used, the

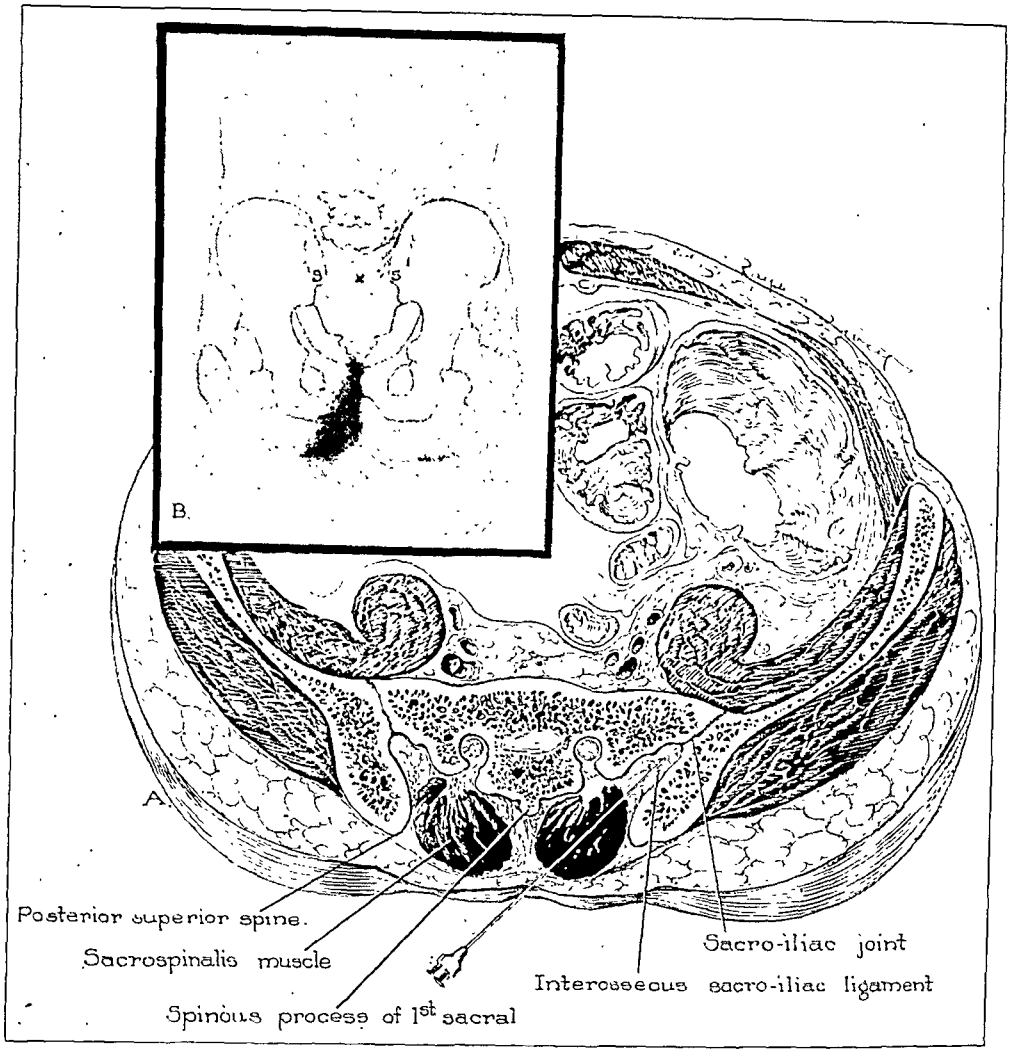



FIG. 1

patients with acute sacro-iliac injuries, although we used this procedure with some benefit in such cases. The first few patients were treated with simple injection, and some improvement was noted. Because of the marked relaxation that occurred after injection, with disappearance of muscle spasm, list, and pain on the straight-leg-raising test, we added the routine use of manipulation of the sacro-iliac joints.

## METHOD

The method of injection and the routine of manipulation are as follows: The patient is placed in the prone position on a table and the sacral region is prepared. It is our practice to administer orally three grains of sodium amytal at this time to prevent any possible reaction from the procaine. About twenty to thirty cubic centimeters of 1-per-cent. procaine is injected. In cases of bilateral sacro-iliac strain, fifteen or twenty cubic centimeters of the solution may be injected into each side. Anatomical studies have shown us that the best approach to the sacro-iliac joint requires the insertion of a long (spinal-puncture) needle at a point over the sacrum midway between the two posterior superior spines

TABLE I (*Continued*)

RESULTS OF INJECTION OF PROCAINE INTO SACRO-ILIAC JOINT

| Case No. | Location of Pain | Clinical Diagnosis | Injection of 1-Per-Cent. Procaine | Immediate Results | | Late Results | |
|---|---|---|---|---|---|---|---|
| | | | | Objective | Subjective | Objective | Subjective |
| 7 | Right sciatic nerve | ? Right sacro-iliac strain (thickened ligamentum flavum) | 20 c.c. in right sacro-iliac joint | Flexion* improved (9 inches to 5 inches) Straight-leg raising improved (60 degrees to 80 degrees) | Transient improvement | Improved after 10 months | Relapse of pain after 1 month |
| 8 | Right sacro-iliac joint and right sciatic nerve | ? Right sacro-iliac strain (protruded fourth lumbar disc) | 20 c.c. in right sacro-iliac joint repeated | Flexion improved (15 inches to 8 inches) Straight-leg raising improved (50 degrees to 90 degrees) | Improved for only 4 hours | No improvement 2 months later | No relief after 4 hours |
| 9 | Right sacro-iliac joint and right sciatic nerve | Right sacro-iliac strain with sciatic pain | 20 c.c. in right sacro-iliac joint | No improvement | No improvement | No improvement | No improvement |
| 10 | Both sacro-iliac joints | Bilateral sacro-iliac strain | 10 c.c. in each sacro-iliac joint | Flexion improved Straight-leg raising improved | Improved | Improved 2 years later | Improved 2 years later |
| 11 | Left sacro-iliac joint and left sciatic nerve | Left sacro-iliac strain | 20 c.c. in left sacro-iliac joint | Straight-leg raising improved (30 degrees to 80 degrees) | Improved | No follow up | |
| 12 | Right sacro-iliac joint and right sciatic nerve | Right sacro-iliac strain and postural strain | 20 c.c. in right sacro-iliac joint | Flexion improved (2 inches to 0) Straight-leg raising improved (85 degrees to 110 degrees) | Immediate improvement | Improvement lasted a few hours only | |
| 13 | Left sacro-iliac joint | Left sacro-iliac strain | 20 c.c. in left sacro-iliac joint | Flexion improved (12 inches to 6 inches) Straight-leg raising improved (50 degrees to 90 degrees) | Immediate improvement | Permanent improvement | No pain 5 weeks later |

* Flexion = distance in inches by which fingers fail to touch floor in forward flexion.

TABLE I

RESULTS OF INJECTION OF PROCAINE INTO SACRO-ILIAC JOINT

| Case No. | Location of Pain | Clinical Diagnosis | Injection of 1-Per-Cent. Procaine | Immediate Results | | Late Results | |
|---|---|---|---|---|---|---|---|
| | | | | Objective | Subjective | Objective | Subjective |
| 1 | Left sacro-iliac joint | Chronic left sacro-iliac strain | 20 c.c. in left sacro-iliac joint | Flexion* improved (12 inches to 6 inches) Straight-leg raising normal | Progressive improvement | No relapse in 4 months | No relapse in 4 months |
| 2 | Left sacro-iliac joint and left sciatic nerve | Left sacro-iliac strain with sciatic pain | 10 c.c. in left sacro-iliac joint | Flexion improved Straight-leg raising improved | Pain disappeared | | No pain 2 days later |
| 3 | Left sacro-iliac joint and left sciatic nerve | Left sacro-iliac strain with sciatic pain | 15 c.c. in left sacro-iliac joint | Flexion improved (6 inches to 0) Straight-leg raising improved (50 degrees to 80 degrees) | Immediate improvement | No permanent relief; cured by sacro-iliac fusion | |
| 4 | Both sacro-iliac joints | Bilateral sacro-iliac strain | 10 c.c. in each sacro-iliac joint | Flexion improved (20 inches to 10 inches) Straight-leg raising improved on both sides | Increased pain, then gradual improvement | Permanent improvement | No relapse in 10 months |
| 5 | Right sacro-iliac joint and right sciatic nerve | Right sacro-iliac strain with sciatic pain | 25 c.c. in right sacro-iliac joint | Flexion improved (8 inches to 4 inches) Straight-leg raising improved (70 degrees to 90 degrees) | Slow progressive improvement | Permanent improvement | No relapse in 2 years |
| 6 | Right gluteal and right sciatic nerves | Right sacro-iliac strain with sciatic pain | 20 c.c. in right sacro-iliac joint | Flexion improved (8 inches to 0) Straight-leg raising improved (60 degrees to 90 degrees) | Increased pain, then gradual improvement | Permanent improvement | No relapse in 1½ years |

* Flexion = distance in inches by which fingers fail to touch floor in forward flexion.

TABLE I (*Continued*)

RESULTS OF INJECTION OF PROCAINE INTO SACRO-ILIAC JOINT

| Case No. | Location of Pain | Clinical Diagnosis | Injection of 1-Per-Cent. Procaine | Immediate Results | | Late Results | |
|---|---|---|---|---|---|---|---|
| | | | | Objective | Subjective | Objective | Subjective |
| 20 | Right sacro-iliac joint and right sciatic nerve | Right sacro-iliac strain with sciatic pain | 20 c.c. in right sacro-iliac joint | No measurements | Immediate improvement | Improved 2 weeks later | Better than in 15 years |
| 21 | Left sacro-iliac joint | Left sacro-iliac strain | 20 c.c. in left sacro-iliac joint | Much improvement | Immediate improvement | No follow-up | |
| 22 | Right sacro-iliac joint and right sciatic nerve | Right sacro-iliac arthritis with sciatic pain | 2 injections in right sacro-iliac joint | No improvement after first injection. Immediate improvement after second injection | Improved after second injection | Still well 16 months later | No complaints 16 months later |
| 23 | Left sacro-iliac joint | Left sacro-iliac strain | 40 c.c. in left sacro-iliac joint | Flexion* improved<br>Straight-leg raising improved (90 degrees to 120 degrees) | Immediate improvement | Marked benefit after 1 week | |
| 24 | Left sacro-iliac joint and left sciatic nerve | Left sacro-iliac arthritis | 25 c.c. in left sacro-iliac joint | Flexion improved (24 inches to 18 inches)<br>Straight-leg raising improved (30 degrees to 70 degrees) | Immediate improvement | Improved 1 week later | Improved 1 week later |
| 25 | Both sacro-iliac joints and both sciatic nerves | Bilateral sacro-iliac strain | 22 c.c. in each sacro-iliac joint | Flexion markedly improved<br>Straight-leg raising improved (10 degrees to 60 degrees) | Immediate improvement | 1 week later flexion and straight-leg raising improved | Improved 1 week later |
| 26 | Left sacro-iliac joint and left sciatic nerve | Left sacro-iliac strain with sciatic pain | 20 c.c. in left sacro-iliac joint; repeated in 1 week | Flexion improved (24 inches to 12 inches) | Immediate improvement | 2 months later still improved | 2 months later still improved |
| 27 | Left sacro-iliac joint | Left sacro-iliac strain | 20 c.c. in left sacro-iliac joint | Considerable immediate improvement | Immediate improvement | No follow-up | |

TABLE I (*Continued*)

RESULTS OF INJECTION OF PROCAINE INTO SACRO-ILIAC JOINT

| Case No. | Location of Pain | Clinical Diagnosis | Injection of 1-Per-Cent. Procaine | Immediate Results | | Late Results | |
|---|---|---|---|---|---|---|---|
| | | | | Objective | Subjective | Objective | Subjective |
| 14 | Right sacro-iliac joint and right sciatic nerve | Right sacro-iliac strain with sciatic pain | 31 c.c. in right sacro-iliac joint | Flexion* improved (8 inches to 5 inches) Straight-leg raising improved (60 degrees to 110 degrees) | Immediate improvement | Improvement 1 month later | |
| 15 | Both sacro-iliac joints and both sciatic nerves | Bilateral sacro-iliac arthritis with sciatic pain | 20 c.c. in each sacro-iliac joint | Flexion improved Straight-leg raising improved (35 degrees to 50 degrees) | Immediate improvement | Still improved 8 weeks later | |
| 16 | Both sacro-iliac joints | Bilateral sacro-iliac strain | 15 c.c. in each sacro-iliac joint | Flexion improved (6 inches to 3 inches) Straight-leg raising not improved | Slight improvement | No improvement 1 week later | |
| 17 | Right sacro-iliac joint | Right sacro-iliac strain | 20 c.c. in right sacro-iliac joint | Flexion improved (3 inches to 2 inches) Straight-leg raising improved (80 degrees to 90 degrees) | Immediate improvement | No follow-up | |
| 18 | Right sacro-iliac joint and right sciatic nerve | Right sacro-iliac strain with sciatic pain | 30 c.c. in right sacro-iliac joint | Flexion improved (24 inches to 18 inches) Straight-leg raising improved (35 degrees to 60 degrees) | Immediate improvement | Improved 5 weeks later | All pain gone 5 weeks later |
| 19 | Right sacro-iliac joint | Right sacro-iliac strain | 40 c.c. in right sacro-iliac joint | Flexion improved (18 inches to 4 inches) Straight-leg raising improved (65 degrees to 80 degrees) | Immediate improvement | Improved 4 weeks later | Improved 4 weeks later |

* Flexion = distance in inches by which fingers fail to touch floor in forward flexion.

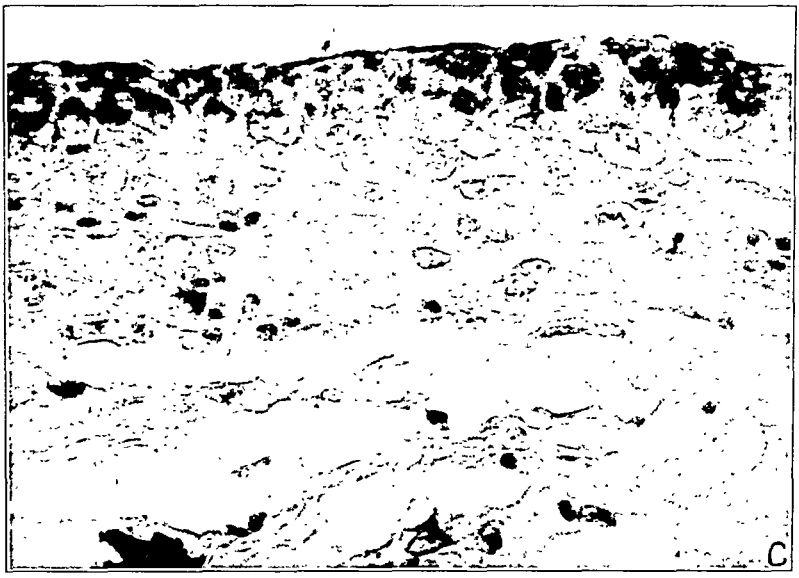



FIG. 1-C
Chronic non-specific synovitis of the knee joint:
Fig. 1-A: Magnification × 105.
Fig. 1-B: Magnification × 178.
Fig. 1-C: Magnification × 490.

tendons; in thirteen of these specimens there was evidence of chronic non-specific tenosynovitis, and in one there was tuberculosis. Thirty-eight specimens were obtained from bursae; in thirty-three of these the bursitis was chronic, in four it was tuberculous, and in one it was gouty. Ninety-one of the specimens were tendon-ganglion cysts. The clinical diagnosis in the majority of the cases corresponded to that made by the pathologist.

We believe that this variety of tissue and the pathological conditions add to the ultimate value of this study.

Among the first observations noted was the difficulty in getting some of the older fixed sections to take the stain. Since this difficulty was not experienced in the more recently removed tissues, with few exceptions, we attributed the failures to the long fixation in the formalin solution used for preservation.

The findings generally noted in these tissues may be summarized as follows: The mucin was found to be present in the synovial layer of the capsule and was not present in the underlying fibrous tissue or in or around the blood and lymph vessels. This can be seen in Figures 1-A and 1-B. The mucin was also noted to be present just at the edge of the membrane next to the articular space, as illustrated in Figure 3. The mucin was more concentrated in the membranous layer than it was in the synovial fluid itself (Fig. 2). The stain was present not only in the cytoplasm of the synovial cells, but also in the nuclei and the intercellular substance, as shown in Figures 1-C, 2, 3, 4, and 5. Degenerating cells found along the

# THE SCIATIC NERVE AND THE PIRIFORMIS MUSCLE: THEIR INTERRELATION A POSSIBLE CAUSE OF COCCYGODYNIA *

BY LINDSAY E. BEATON, M.D., AND BARRY J. ANSON, M.D., CHICAGO, ILLINOIS

*From Northwestern University Medical School, Chicago*

Considerable interest has recently been expressed in the relation of the piriformis muscle to sciatic pain.[2, 3, 4, 5] In the course of laboratory studies upon various anatomical features, the authors encountered arrangements of piriformis muscle and sciatic nerve which might account for the production of pain in coccygodynia. These anatomical arrangements may be briefly described.

Usually the sciatic nerve emerges from the pelvis by passing beneath the piriformis muscle. The muscle, however, may split into two heads; the nerve may also divide within the pelvis into its tibial and common peroneal portions. Thus six combinations are possible. Only four (Figs. 1, *a* through 1, *d*) of the six types of arrangement have been represented in our 240 specimens examined consecutively; the percentage occurrence of each of the four is recorded in Table I **.

TABLE I

ANATOMICAL ARRANGEMENTS OF PIRIFORMIS MUSCLE AND SCIATIC NERVE

| | No. of Cases | Per Cent. |
|---|---|---|
| Undivided nerve below undivided muscle | 216 | 90.0 |
| Divisions of nerve through and below divided muscle | 17 | 7.1 |
| Divisions above and below divided muscle | 5 | 2.1 |
| Undivided nerve between heads | 2 | 0.8 |
| Divisions between and above heads | 0 | 0.0 |
| Undivided nerve above undivided muscle | 0 | 0.0 |

Of our twenty-four cases (10 per cent.) of variations, eight occurred unilaterally. The other sixteen cases were bilateral (that is, on both sides of eight bodies). Of the eight unilateral, three were of the right side, five of the left.

Basing an opinion upon the results of these anatomical observations, it would seem that pain during muscle spasm might be produced through compression of the sciatic nerve, or one of its subdivisions, in those cases in which either the nerve or its subdivision passed between heads of the divided muscle (Figs. 1, *b* and 1, *d*); and that a similar result might follow

* Contribution No. 271 from the Anatomical Laboratory of Northwestern University Medical School.

** To an original group of 120 specimens, previously reported by the present authors,[1] an equal number has since been added, and this table includes both groups.

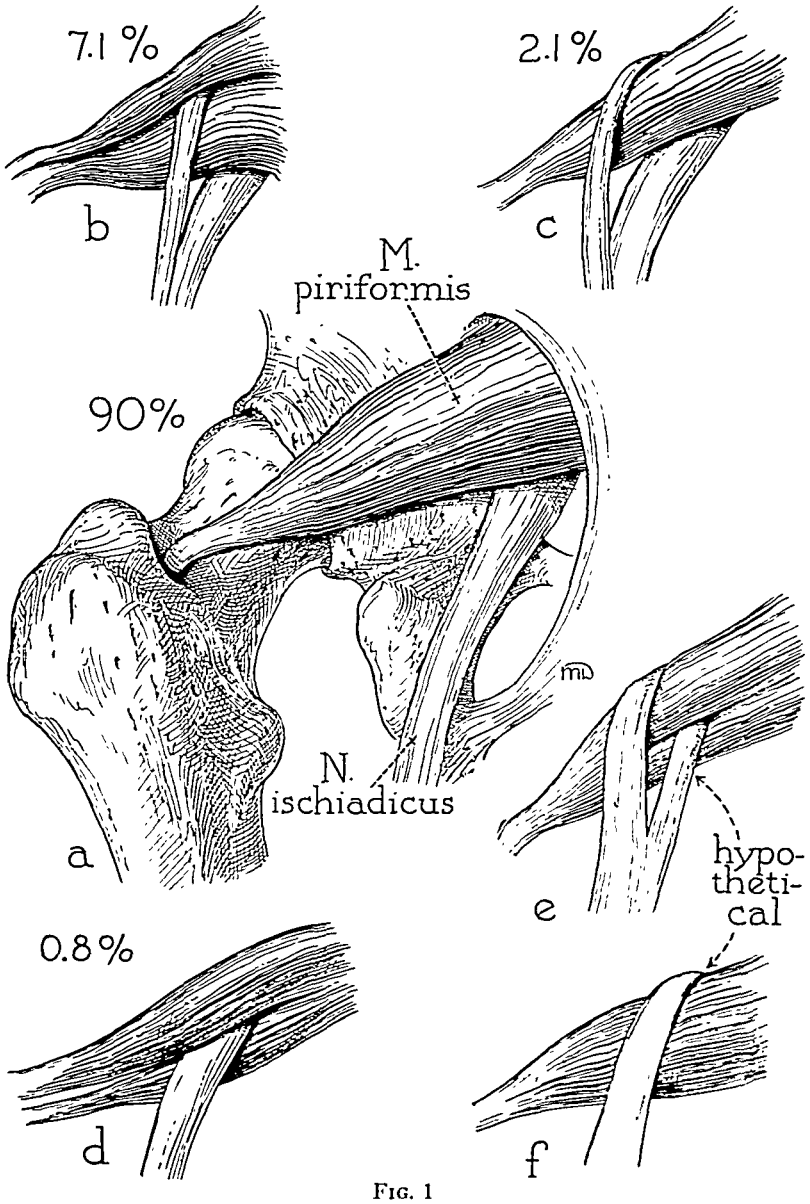



FIG. 1

Six types of arrangement of the sciatic nerve, or of its subdivisions, in relation to the piriformis muscle, arranged in the order of frequency. Gluteal (external) view. The percentage incidence in 240 examples is indicated. Figures *e* and *f* are hypothetical; the others are actual cases.

*a:* Nerve undivided passes out of greater ischiadic foramen, below piriformis muscle.

*b:* Divisions of nerve pass through and below heads of muscle.

*c:* Divisions above and below undivided muscle.

*d:* Nerve undivided between the heads of muscle.

*e:* Divisions of nerve between and above heads (hypothetical).

*f:* Undivided nerve above undivided muscle (hypothetical).

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| | No. of Cases | Per Cent. |
|---|---|---|
| Undivided nerve below undivided muscle | 216 | 90.0 |
| Divisions of nerve through and below divided muscle | 17 | 7.1 |
| Divisions above and below divided muscle | 5 | 2.1 |
| Undivided nerve between heads | 2 | 0.8 |
| Divisions between and above heads | 0 | 0.0 |
| Undivided nerve above undivided muscle | 0 | 0.0 |

Of our twenty-four cases (10 per cent.) of variations, eight occurred unilaterally. The other sixteen cases were bilateral (that is, on both sides of eight bodies). Of the eight unilateral, three were of the right side, five of the left.

Basing an opinion upon the results of these anatomical observations, it would seem that pain during muscle spasm might be produced through compression of the sciatic nerve, or one of its subdivisions, in those cases in which either the nerve or its subdivision passed between heads of the divided muscle (Figs. 1, *b* and 1, *d*); and that a similar result might follow

* Contribution No. 271 from the Anatomical Laboratory of Northwestern University Medical School.

** To an original group of 120 specimens, previously reported by the present authors,[1] an equal number has since been added, and this table includes both groups.

# CORD INJURY DURING REDUCTION OF THORACIC AND LUMBAR VERTEBRAL-BODY FRACTURE AND DISLOCATION *

BY WILLIAM A. ROGERS, M.D., BOSTON, MASSACHUSETTS

Among seventy cases of fracture and dislocation of the thoracic and lumbar vertebral bodies which the author has treated during the past nine years, four are especially notable from the standpoint of cord or root pressure resulting from treatment. Two were fracture-dislocations and two showed crush fractures involving the posterior wall of the centrum with backward displacement of the bone fragments. In all four cases, there was no evidence of cord or root pressure immediately following the injury. In three cases paralysis developed as a result of treatment: in the two fracture-dislocation cases, during reduction; and in one of the fracture cases, two years after the injury. In none of the other sixty-six cases having the usual wedge compression was there the slightest evidence of cord or root pressure incident to treatment.

In view of this experience and because of anatomical and pathological considerations, the writer has divided his cases from the standpoint of cord hazard into two groups,—the safe and the dangerous. The safe group includes all vertebral-body fractures which do not involve the posterior wall of the centrum, probably over 90 per cent. The dangerous group includes all dislocations and all fractures involving the posterior wall of the centrum.

## FRACTURE OF THE POSTERIOR WALL OF THE CENTRUM

CASE 1. Figures 1-A and 1-B are the roentgenogram and post-mortem specimen of a woman, aged forty-six, who died of shock a week after she had jumped, with suicidal intent, from a forty-foot height, crushing the feet and ankles and fracturing the second and fourth lumbar vertebrae. The fourth lumbar vertebra was comminuted, and fracture lines involved the posterior wall of the centrum, fragments of which had been forced backward into the neural canal. While there was no clinical evidence of root pressure, Figures 1-A and 1-B show that the lumen of the canal was seriously narrowed. The patient was in severe pain, and symptoms of shock were still present a week after the injury. At that time, in an effort to relieve pain by jacket fixation, an attempt was made to reduce this fracture by traction-extension without altering the shape of the bone in any way.

The author has included this type of fracture in the dangerous group because, obviously, the factor of safety of the cauda equina is low. If the surgeon elects to attempt reduction in these cases, powerful traction should precede and accompany extension. The writer's present policy is not to hyperextend the spine in these cases, but merely to apply jacket fixation to protect the bone until union is complete,—that is, in about four months.

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

mere stretching of the nerve when it leaves the pelvis superior to the undivided muscle (Fig. 1, *c*). In cases of chronic inflammation of the piriformis muscle, it would seem that any one of these anomalous arrangements of muscle would bring nerve and muscle into closer relationship, and intensify the involvement of the former.

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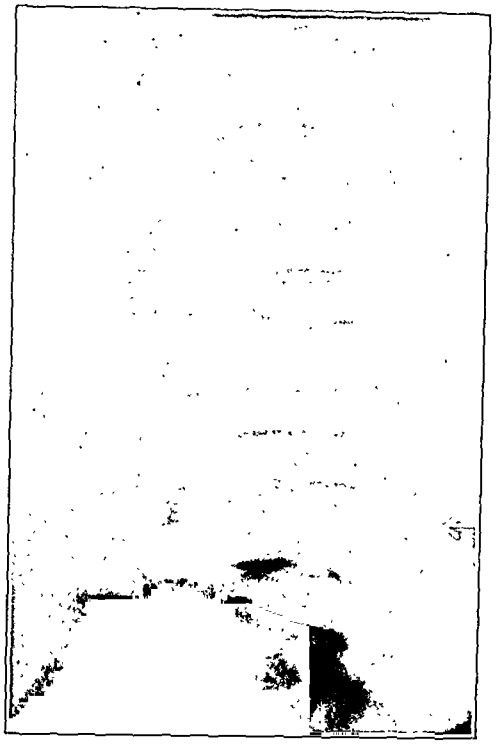


FIG. 1-A

Case 1. Crush fracture involving the posterior wall of the centrum of the fourth lumbar vertebra. Mild wedge-shaped compression fracture of the centrum of the second lumbar vertebra.



FIG. 1-B

Case 1. Post-mortem specimen.

CASE 2. A boy, nineteen years of age, was injured in an automobile collision in August 1926. He complained of backache. Roentgenographic examination in another hospital was reported negative, and the patient was kept there in bed for three weeks. He then resumed normal activities, and was without complaint for two years when symptoms of cord pressure slowly developed over four months until he could no longer walk because of spastic paraplegia. He was seen by Dr. John Hodgson of the Neurosurgical Service with whom the author saw him in consultation and during treatment. Roentgenograms, unfortunately destroyed, showed an old wedge compression fracture of the fourth thoracic body with massive callus projecting backward into the neural canal. There was a complete block in the canal. These observations were confirmed at laminectomy; cord pressure was relieved at that time by splitting the dura, and further deformity was prevented by spine fusion.

This case illustrates the effect of virtually ignoring a fracture involving the posterior wall of the centrum. Excess posterior callus and increasing deformity finally caused functional interruption in the cord. Laminectomy and spine fusion permanently relieved the trouble.

### FRACTURE-DISLOCATION

CASE 3. As shown in Figure 2-A, the patient, a woman, aged thirty-eight, had sustained a fracture-dislocation of the eleventh thoracic vertebra upon the twelfth. After three days of gradual extension on the flexible frame, marked partial motor paralysis of the lower extremities, loss of reflexes, and abdominal distention developed. Extension was at once diminished, and, after three days, all neurological signs had disappeared. The reduction was not completed. (See Figure 2-B.)

Figure 3 illustrates the mechanism of cord pressure which may occur

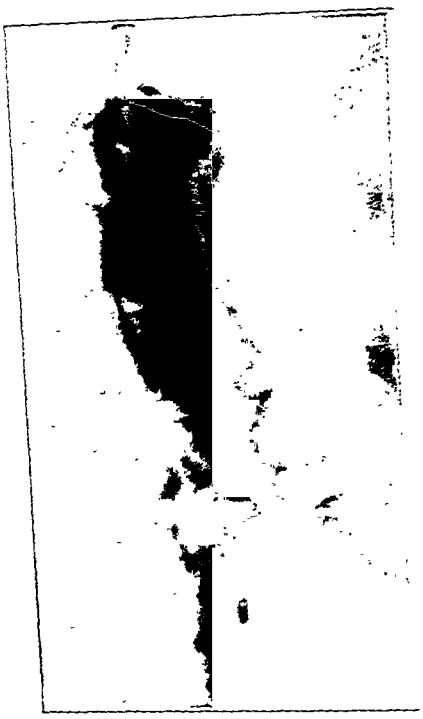


FIG. 2-A

Case 3. Roentgenogram on admission, showing fracture-dislocation of the eleventh and twelfth thoracic vertebrae.



FIG. 2-B

Case 3. Correction obtained by traction-extension. The dislocation has not been reduced; posterior replacement of the eleventh thoracic vertebra has not occurred.

through manipulative extension in a case of dislocation when the dislocated vertebra does not move backward into normal alignment with its fellows. The author is satisfied that failures to effect posterior replacement have been due to locking of the posterior articulations. This may be demonstrated at open reduction.

CASE 4. The patient, a man of twenty-nine, had been thrown from an automobile. For a day after the accident, there had been little or no evidence of root pressure. Slowly spreading paralysis then developed in scattered groups in both lower extremities. On the third day he was transferred from a distant hospital to the Service of Dr. W. J. Mixter with whom the writer saw him in consultation. Figure 4-A shows the condition on admission. The diagnosis of fracture-dislocation of the first

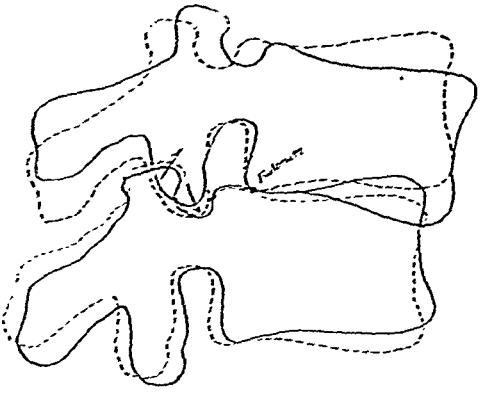


FIG. 3

Diagram showing the effect of extension in fracture-dislocation when the posterior articular processes do not engage normally. If the processes do not lock to prevent further extension, cord or root injury may result from the manoeuver by encroachment of lamina and processes on the neural canal, as occurred in Case 3.

locked, or if it is apparent that they will lock in extension, open reduction should be done, and the processes should be freed by flexion of the column and realigned. Longitudinal traction will not draw the involved vertebrae apart far enough to free the articular processes if they are locked.

If the vertebral body is displaced forward and the articular processes are intact and in normal alignment, as revealed by an anteroposterior roentgenogram taken immediately before reduction, traction and extension will probably effect reduction. This should not be done under a general anaesthetic. Morphine and scopolamine will provide adequate muscle relaxation. If the articular processes do not engage normally during extension, the ma-

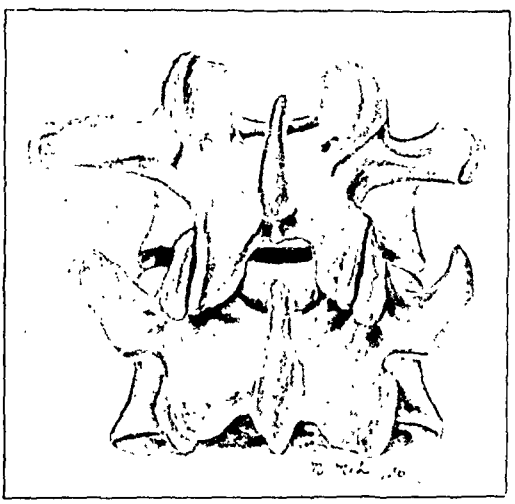


FIG. 8

Case 4. Reduction completed by extension, after realignment of the articular processes.

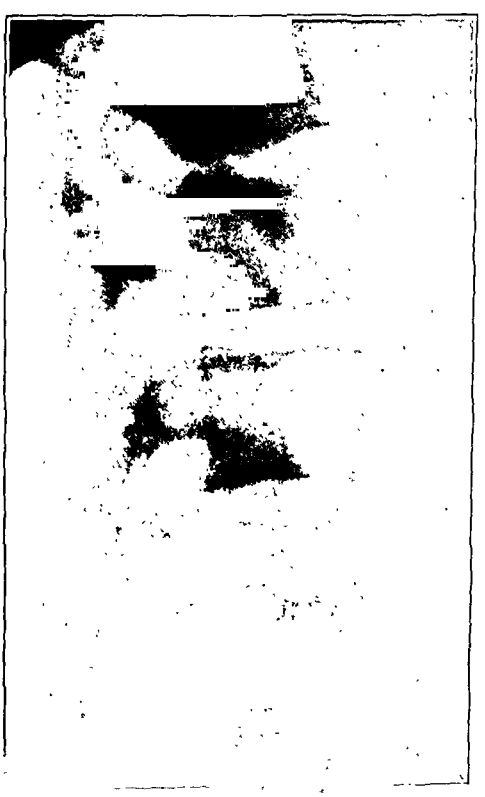


FIG. 9-B

One year after open reduc- neurological signs have

FIG

Roent medi-
open re

noeuver should be abandoned, and open reduction should be performed. This may be very difficult, and is always a dangerous operation.

If the vertebral body is displaced forward and the articular processes are not in line (Fig. 5), extension is dangerous and will fail. Open reduction—employing flexion, rotation, and extension in the order mentioned—is the safest and most efficient means at present.

Where displacement of the centrum is lateral, the articular processes are commonly fractured. In such a case they will probably not lock to prevent reduction. Traction and manipulative replacement medially, with or without subsequent extension, are indicated. This manoeuver has been successfully accomplished by Fürster, and others.

In the case of dislocation of the upper thoracic vertebrae, the problem of reduction very rarely comes up. The injuring force either kills the patient or is spent in producing other fractures or dislocations. If the author were confronted with this problem in a patient requiring reduction, he would proceed immediately with open reduction.

## CONCLUSIONS

1. Crush fractures, involving the posterior wall of the vertebral body, and all fracture-dislocations are potentially dangerous from the standpoint of cord injury during reduction.

2. In the reduction of vertebral-body dislocation in the thoracic or lumbar region, it is essential that the alignment of the articular processes be determined accurately before reduction is attempted. If there is lateral disalignment, the reduction should be open, and flexion should be employed to disengage the locked processes.

3. Extension of the spine in the presence of vertebral-body dislocation with lateral displacement of the articular processes may injure the cord or nerve roots. It should never be employed until the articular processes are in line.

4. Traction alone will not free locked articular processes.

5. Vertebral-body fracture, involving the posterior wall of the centrum, is potentially dangerous from the standpoint of spinal-cord or nerve-root pressure.

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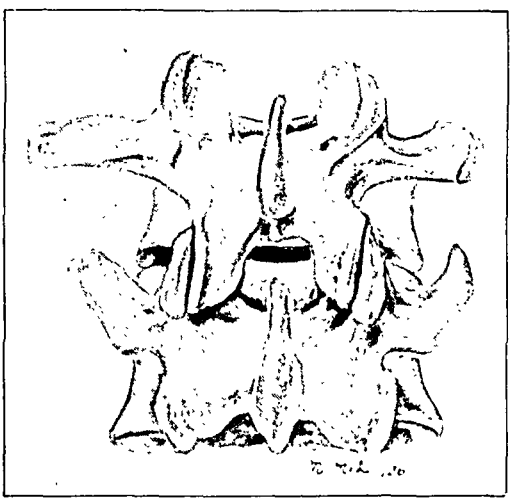


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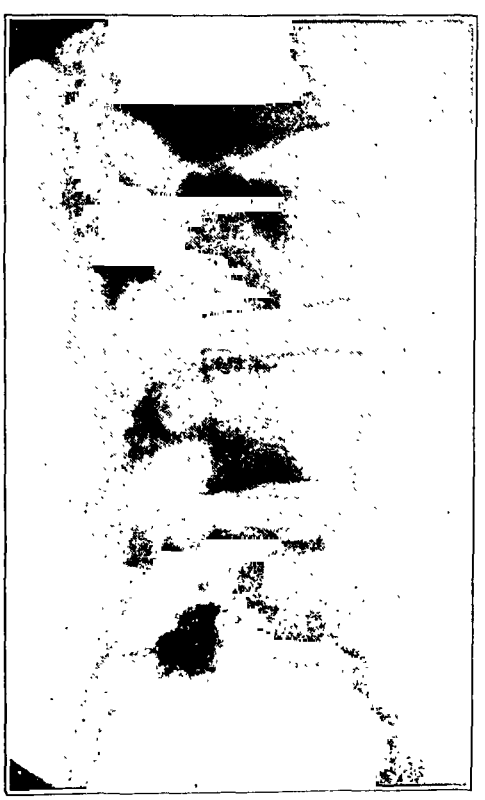


FIG. 9-A

Case 4. Roentgenogram immediately after open reduction.

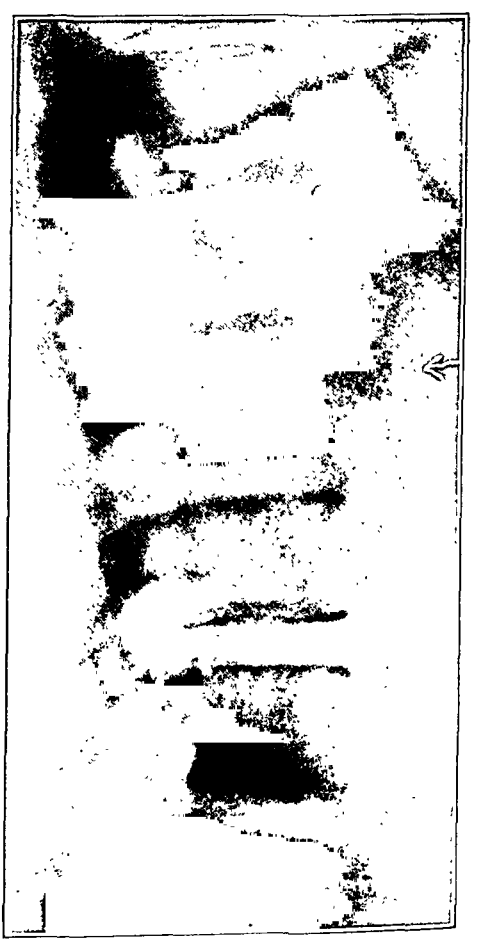


FIG. 9-B

Case 4. One year after open reduction. All neurological signs have disappeared.

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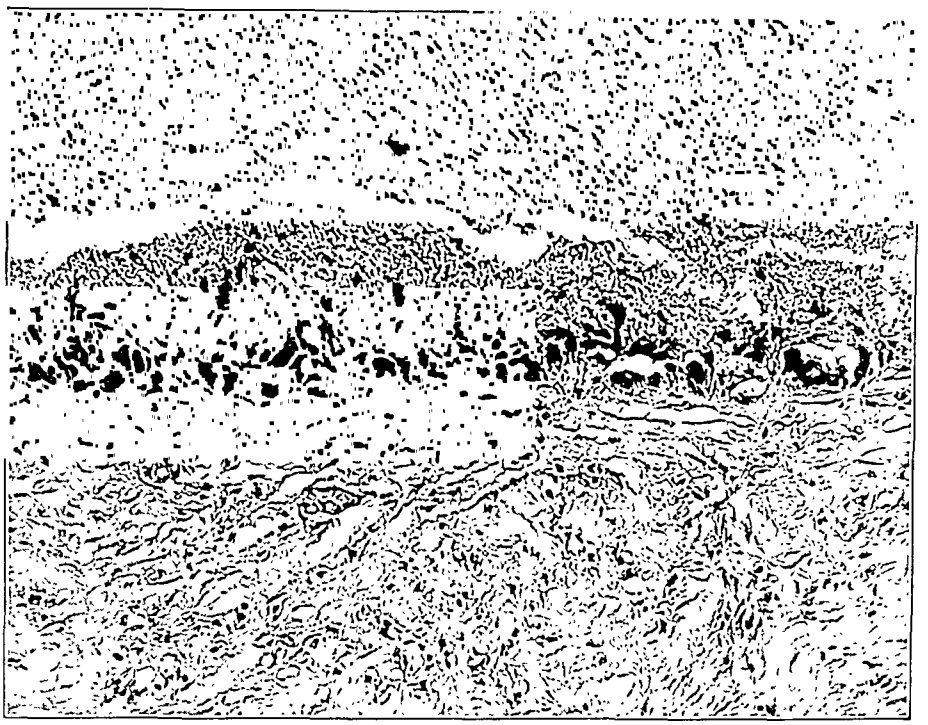


FIG. 2

Chronic bursitis of the olecranon (× 140).

edges of the membrane and in the fluid itself contained mucin, as demonstrated by the presence of the dye (Figs. 1-C, 2, 4, and 5). A control stain used on a section of the glandular portion of the wall of a human stomach showed that the mucin-producing cells of this organ, which are true glandular epithelial cells, took the dye quite differently from the synovial

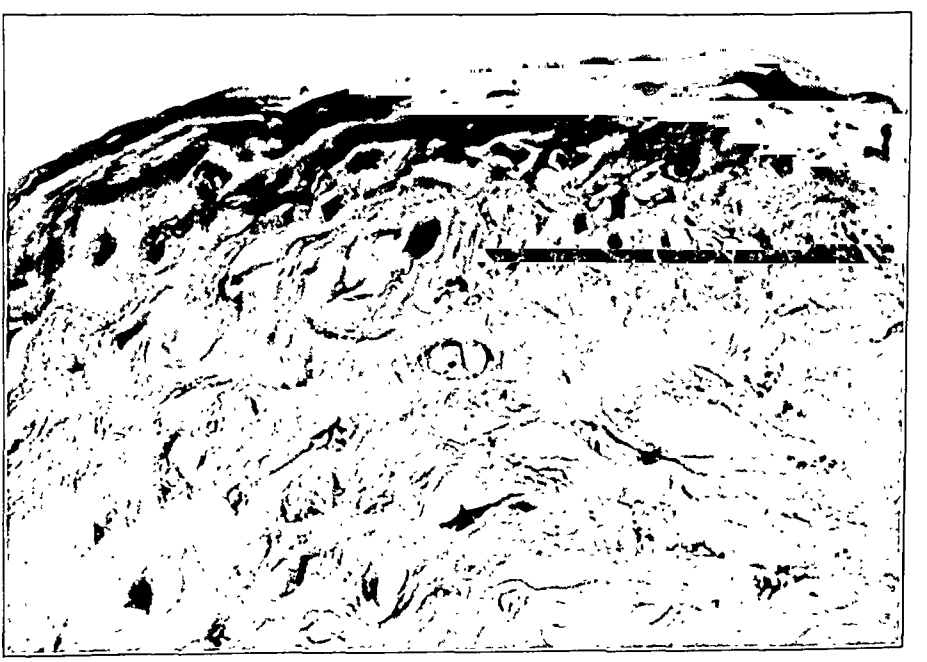


FIG. 3

Chronic bursitis of the wrist joint (× 475).

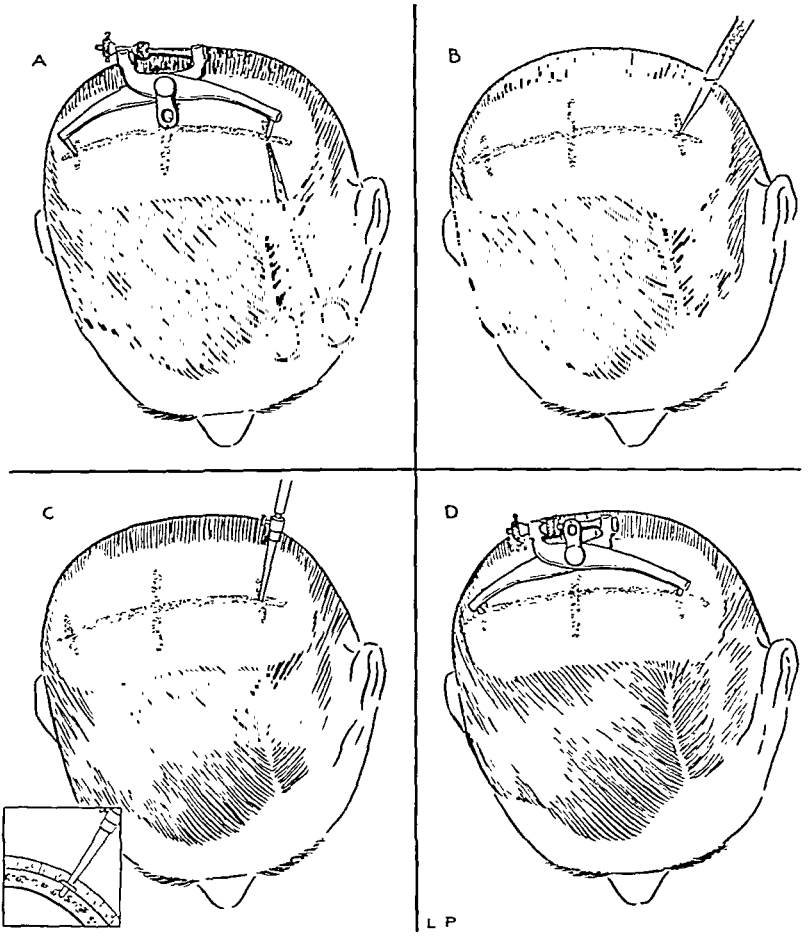



FIG. 1

The author's method of applying skeletal traction for the treatment of fracture-dislocations of the cervical spine.

*A:* For correct placement of the skull tongs, lines are painted on the scalp to indicate the mid-line of the skull and the approximate plane of the cervical articulations (above mastoid tips). With the traction bar resting on the mid-line, the points of the tongs are brought down upon the transverse line. These points of contact are marked for the placement of stab wounds.

*B:* After injection of novocain (1 per cent.), stab wounds just large enough to admit the drill guard (inset *C'*) are made down to the skull.

*C:* The drill point is forced to a depth of three millimeters in children and four millimeters in adults. The fixed guard prevents excessive penetration.

*D:* The points of the tongs are fitted into the bone perforations and held in position until the tongs have been locked. (*Courtesy of the American Journal of Surgery.*)

and old fracture-dislocations of the cervical spine. Of this number, fourteen died as a result of spinal-cord and associated injuries, without follow-up roentgenographic examinations.

Although the results have been analyzed on the basis of the twenty-nine cases with roentgenographic studies during treatment, it should be stated that the relief of nerve-root pain afforded those patients with

# TREATMENT OF INJURIES OF THE CERVICAL SPINE*

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Experience with skeletal traction for reduction of fracture-dislocations of the cervical spine has now been sufficient to prove its value as a method of choice in the treatment of these injuries. Headache and other disagreeable symptoms which may have been expected from the application of a strong pulling force against the skull have not been present. No patient treated by this method has complained of pain in the head or in the neck, only of a pulling sensation in the cervical region when heavy traction is applied.

We have observed no unfavorable results which could be attributed to the use of skeletal traction, except in one patient who was being treated for osteomyelitis of the cervical spine and in whom, after three weeks of continuous traction, a mild bone infection developed around the points of the tongs. Several traumatic cases have been treated for longer periods (three to six weeks) without infection. There has been no augmentation of spinal cord or nerve injury. It is conceivable that prolonged heavy traction could damage the spinal-nerve roots and for this reason, as well as for that of protecting the spinal ligaments, we have not used force in excess of twenty-five pounds.

The potential complications from skull traction are possibly somewhat greater than those arising from the use of skeletal traction elsewhere in the body, but the conditions for which skull traction is applied are such that the risks are more than justifiable.

Any method of treatment applicable to all patients with fracture-dislocations of the cervical spine must be planned in accordance with fundamental nursing requirements. To permit uninterrupted traction during changes of position for protection of the patient's skin, small tongs were designed for application to the vertex of the skull. This instrument was used on all except the first three patients in this series, and to them modified femur tongs were applied. McKenzie uses special tongs that insert into the lateral surfaces of the skull. To obtain traction, Hoen and Cone and Turner insert wires extradurally through burr holes in the skull. While this method is effectual, it requires some knowledge of intracranial surgery, and it is more time-consuming than the application of tongs through which the same effectual traction can be accomplished. Neubeiser inserts hooks under the zygomata. An objectionable feature of this method is that traction is applied in a plane anterior to that of the cervical articulations.

We have used skeletal traction on forty-three patients with recent

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

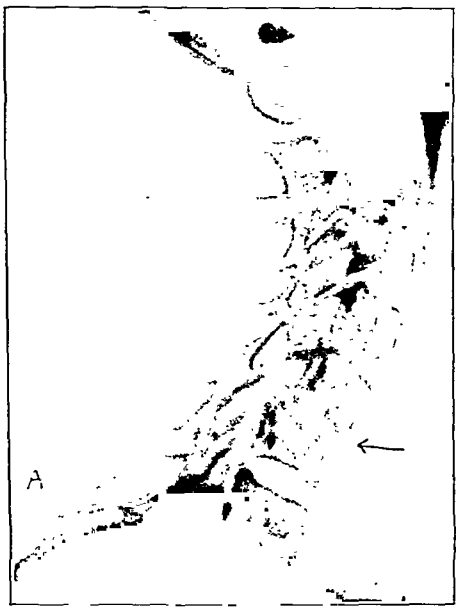



FIG. 5-A

Dislocation of seven weeks' duration.

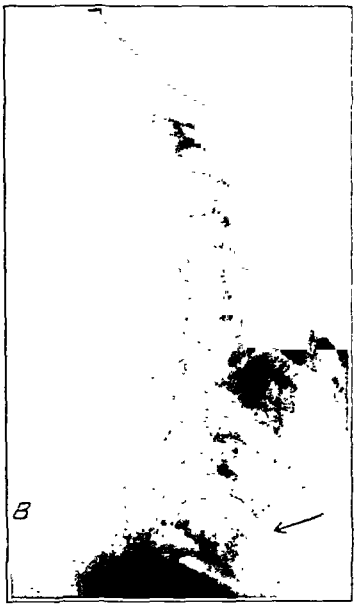



FIG. 5-B

First follow-up film made four days after the application of eighteen pounds of traction. There was relief of symptoms arising from nerve-root injury.

progressive paralysis with clinical findings simulating those of a hopeless cord lesion, but, when these conditions develop under such circumstances, the prognosis would be more favorable than if the same findings were the immediate results of injury.

Skeletal traction affords relief for a group of cases that heretofore presented a difficult problem,—those patients with fractures or fracture-dislocations of the cervical spine, who, for one reason or another, do not receive early treatment. Some patients are not handicapped by reason of an uncorrected spinal deformity, while others are partially or totally disabled as a result of pain, paraesthesia, or paralysis in the upper extremities, due to pressure on the spinal-nerve roots caused by the spinal deformity. In this latter group of cases, even after bone-productive changes are demonstrable, relief of symptoms through partial reduction or disimpaction of a fracture may be obtained by the use of skeletal traction, thus eliminating the necessity for open reduction or the intradural section of sensory roots for relief of intractable pain. The following case is illustrative of this group.

E. P., male, aged twenty-one, fell down a flight of steps on October 23, 1937. When he regained consciousness thirty minutes later, his neck was painful and his arms were weak. On the following day, he complained of a burning, tingling sensation along the ulnar aspects of both arms. In the meantime, motor power had increased. After six days, the right arm was less painful, but, from this time on, there developed a progressive paralysis of the left arm and hand. Upon admission to the hospital, six and one-half weeks after injury, the patient complained of pain and stiffness in the neck, numbness and pain in both arms, and weakness of the left arm and hand. Examination revealed

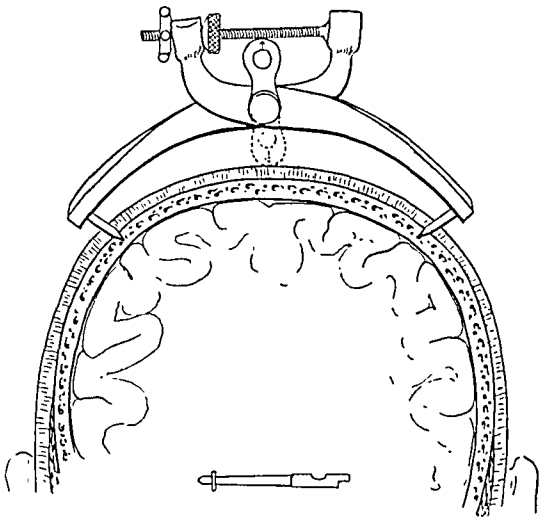


FIG. 2

FIG. 2

Correct position of the points of the tongs. When applied in this manner and tightened daily, especially during the first few days, the tongs will not pull out. The skull should not be drilled blindly except when using a drill point with a fixed guard. (See inset.)

hopeless cord lesions was worthy of the effort expended. Some of these patients were too ill to be disturbed, while others were treated in hospitals without facilities for examination with portable x-ray machines. Apart from the relief of pain, correction of the spinal deformity is desirable in all patients with seemingly hopeless cord lesions, to give them the benefit of any doubt arising from failure to decompress the spinal cord. This applies especially to those patients who receive their first neurological examination several hours or days after injury. During this interval, oedema of the cord or hematomyelia may cause an unobserved

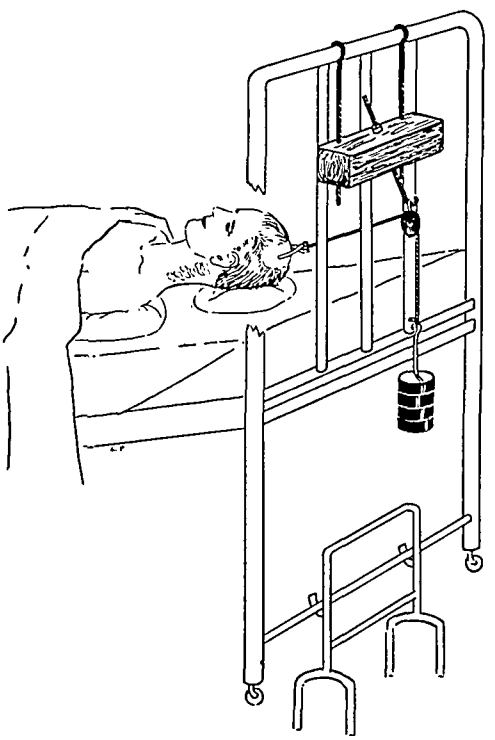


FIG. 3

The traction apparatus is of simple construction and does not hinder the routine care of the patient.

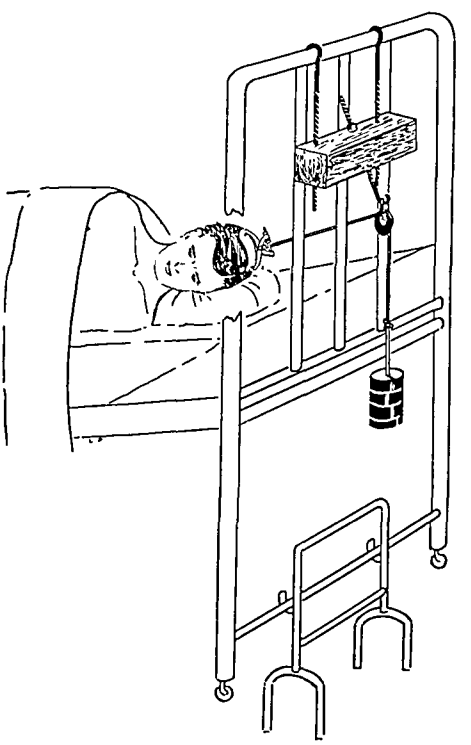


FIG. 4

The patient may be turned to either side while traction is in force. Change of position not only adds to the patient's comfort, but is extremely necessary for the prevention of pressure sores, especially when the spinal cord is severely injured.




FIG. 7-A

Redislocation. Film made three and one-half months after patient's discharge from hospital.




FIG. 7-B

Slight improvement. Film made eighteen days after continuous application of twenty-five pounds of traction. Relief of nerve-root and spinal-cord symptoms resulted.

examination at this time revealed a more marked deformity than was shown originally (Fig. 7-A). Traction resulted in complete relief of nerve-root and spinal-cord symptoms, but, inasmuch as dense bone-productive changes had already occurred, there was only moderate correction of the spinal deformity, although twenty-five pounds of traction was maintained for one month. (See Figure 7-B.) Since discharge from the hospital three months ago, the patient has had only the support of a Thomas collar, yet there has been no return of symptoms.

In recent cases, reduction is accomplished usually within a few minutes or hours. With the application of efficient and properly directed traction, the danger of an increasing deformity is eliminated, and almost immediately thereafter partial or complete reduction may be demonstrated. Reduction, immobilization in plaster, and removal of the tongs all within a few hours, as advocated by Gallie, are of course desirable and should be practised when possible. In our experience, however, this plan of procedure has not always been practicable, inasmuch as many of our patients have been too ill for immediate immobilization.

The plan of treatment which we usually follow is to apply traction at once, and on the following morning an examination by means of a portable x-ray machine is made. If reduction has been accomplished, those patients with little or no cord injury are immobilized in plaster as soon as circumstances will permit; whereas those patients with complete transverse cord lesions are kept in light traction (four to six pounds) until they

limitation of motion in the cervical spine and marked impairment of motor function in the left arm and hand. The patient was unable to extend the forearm, hand, or fingers. Also there was inability to move the fingers laterally. Atrophy of the triceps brachii, of the adductor pollicis, and of the interossei muscles was present. Roentgenographic examination revealed an anterior dislocation of the sixth cervical vertebra on the seventh (Fig. 6-A).

*Treatment:* Skull tongs were applied and to these a weight of twenty-five pounds was attached. The first follow-up roentgenographic examination, made four days later, showed partial reduction. Satisfactory reduction was demonstrated on the seventh day of treatment (Fig. 6-B), following which traction was reduced to fourteen pounds for six days and then to six pounds for three weeks. With traction in force, a plaster jacket was applied.

This patient is now free of root pain; and improvement in motor power, which began within a few days after the application of traction, has continued. Useful function is now present in all muscle groups.

This patient revealed no evidence of spinal-cord injury. His principal disability was caused by progressive nerve-root compression which would have resulted in complete disability of the arm and hand had it not been possible to effect at least a partial correction of the spinal deformity. The results obtained in a similar case are of interest in this connection.

The patient was treated soon after injury and a satisfactory reduction was accomplished. Three and one-half months later, she was referred back to us complaining of severe pain in the left arm and of numbness in the right arm and leg. Roentgenographic




FIG. 6-A

Dislocation of six and one-half weeks' duration.




FIG. 6-B

Result after seven days with twenty-five pounds of traction.




FIG. 9-A

Recent dislocation.




FIG. 9-B

First follow-up film made on the morning following the application of twenty-five pounds of traction.

tion were treated early in the series, when we were hesitant about the use of a strong pulling force. A maximum of only eighteen pounds of traction was applied,—a force inadequate for reduction in some of the more recent cases.

In all of the twenty-seven cases treated within two months of injury, partial or complete reduction was effected. Reviewed in the light of our present conception of therapeutic force, five of the seven cases showing partial reduction received inadequate traction.

The results as a whole have been encouraging, especially since many of the incomplete reductions occurred early in the development of this method of treatment, when there was no precedent to follow. Proceeding cautiously, the maximum force was increased from nine to fifteen to twenty and then to twenty-five pounds for dislocations in the middle and lower thirds of the cervical spine. In the upper third, ten to fifteen pounds has been sufficient in most of the recent cases. It has seemed desirable to bring about the reduction with a minimal force to prevent soft-tissue injury. Although we have never considered it necessary or advisable to effect a rapid reduction, however, such is possible by increasing the force to a point approaching that used for manual reduction.

NOTE: The author wishes to express his appreciation to Dr. C. C. Coleman, Chief of the Department of Neurological Surgery, for the privilege of presenting this material from his Service, and to Dr. E. G. Grantham for his aid in the preparation of the data

TABLE I

ANALYSIS OF TWENTY-NINE CASES * WITH FOLLOW-UP ROENTGENOGRAPHIC EXAMINATIONS

| Cases | Time Elapsing Before Treatment | Result |
|---|---|---|
| 2 | 4 months plus | No improvement. |
| 1 | 2 months | Reduction. |
| 1 | 7 weeks | Partial reduction. |
| 1 | 5 weeks | Partial reduction. |
| 1 | 4 weeks | Reduction. |
| 1 | 3½ weeks | Partial reduction. |
| 18 | 3 weeks or less | Reduction. |
| 4 | 3 weeks or less | Partial reduction. |

* Patients treated by Dr. C. C. Coleman and Dr. W. G. Crutchfield, Dr. J. M. Meredith, Dr. E. G. Grantham, Dr. J. L. Thomson, and Dr. E. H. Anderson.

have at least passed the critical ten-day period. Approximately 80 per cent. of the patients in this series with hopeless cord lesions died within ten days. To immobilize these patients in plaster not only adds to their discomfort, but contributes nothing to their welfare.

The results obtained in the twenty-nine cases with roentgenographic studies during treatment are shown in Table I.

The two patients with dislocations of more than four months' dura-




FIG. 8-A

Fig. 8-A: Recent dislocation.




FIG. 8-B

Fig. 8-B: First follow-up film made on the morning following the application of twenty-five pounds of traction.



FIG. 4
Ganglion of the wrist joint (× 430).

cells (Fig. 6). The mucin was found to be present with a mottled, uneven appearance in the cytoplasm of the cells of the stomach and was not present in the nuclei. The greatest concentration of mucin was in the portion of the cytoplasm near the acinic space and in the opposite pole from the nucleus. In the synovial cells, on the other hand, the greatest concentration of mucin was in or about the nuclei. Mucin was demonstrated to be present not only in all the structures which contained synovial membrane, but also in sections of these structures in the presence of all the mentioned pathological conditions.

## COMMENT

The demonstration of mucin in such a high concentration in the synovial cells is indicative to us that these cells are the main, if not the only, source of mucin in the synovial fluid. (It will be noted that the words "mucin" and "mucoproteins" have been used interchangeably, since it is generally conceded that mucin is a mucoprotein.[19]) Whether the mucin is a product of secretion depends on just what is meant by a true secretion. We usually think of a true secretory gland as one whose product is given up as a result of normal metabolic activity without death of the cell. If the product is a direct result of disintegration of the cellular structure with cessation of normal cellular function, then it is not a true secretion.

There are two main reasons why we believe that the mucin in the synovial fluid is a result of cellular disintegration and not a true secretion: First, innumerable degenerating cells could be demonstrated along the

placed toe and the metatarsus varus on the right. The tarsal bones all presented ossification centers several years in advance of the patient's bone age. The first metatarsal on the right was short and about twice the normal width. The epiphysis was just beginning to ossify. The head of the first metatarsal was quite irregular, with an oblique, pointed end. The first phalanx was at a right angle to the first metatarsal and had the appearance of an accessory toe.

*Treatment*

At operation, on February 18, 1935, an incision was made in the old scar on the dorsum of the displaced toe, extending back to the tarsal region. The tendon of the tibialis anterior was found attached to the base of the first metatarsal, from which it was released and transferred back to the cuneiform bone. There were four tendons attached to the metatarsal and the phalanges. The main tendon of the extensor hallucis longus was not disturbed, but the others were severed and allowed to retract. The first metatarsal was broad and looked like two fused bones. The outer half (toward the second toe) was removed. The deviated phalanges were brought over as near as possible to normal position and held with strong sutures. A cuneiform osteotomy was performed at the base of the first metatarsal. Incisions were made over the remaining four metatarsals which were osteotomized near their bases.

Two years after the first operation, the toe deformity recurred almost to its original position. The mother consented to the removal of the toe, as it was of considerable annoyance and discomfort to the child and it was difficult to get a properly fitting shoe. From a functional standpoint this displaced toe was of little value, but it was thought that its replacement would improve the appearance of the foot and save the child some embarrassment. Another attempt seemed warranted before sacrificing the toe.



FIG. 2

Roentgenogram of the patient's feet on admission.

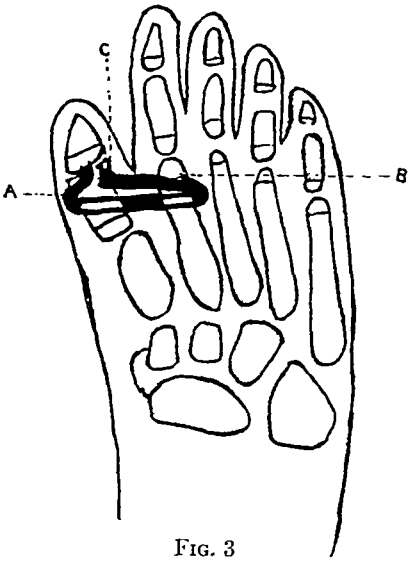



FIG. 3

Diagrammatic drawing of the right foot after the second operation, showing the loop of tendons extending around the first phalanx of the big toe and the second metatarsal.

*A:* Extensor hallucis longus.

*B:* Site of suture.

*C:* Accessory extensor hallucis longus.



FIG. 4

Roentgenogram of the right foot, taken on November 18, 1937, showing the position of the first toe and a good correction of the metatarsus varus.

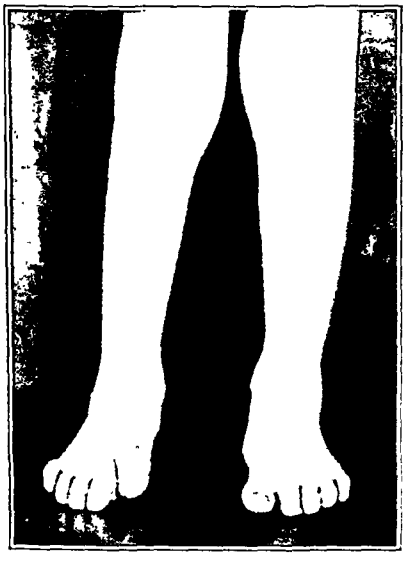


FIG. 5

Photograph of the patient's feet five months after the second operation.

Therefore, on September 20, 1937, a second operation was performed. An incision was made in the old scar on the dorsum of the first toe. The extensor hallucis longus tendon was severed well up in the tarsal region and the proximal end was sutured to the tibialis anterior tendon. The distal portion of the tendon was pulled down to its insertion. The first phalanx was then lined up with the metatarsal by removing some of the head of the metatarsal and by an osteotomy of the first phalanx. The free end of the extensor hallucis longus tendon, which had been pulled down to its insertion, was passed around the inner side and under the first phalanx to the under surface of the second metatarsal. It was then brought around the lateral border of the second metatarsal. The accessory extensor hallucis longus tendon was then severed at the base of the first metatarsal, and the free distal end was pulled over to the second metatarsal, where it was united to the free end of the main tendon

tion the writer is unable to explain. This should not be confused with a loose body in the joint, nor with a displaced medial epicondyle. Striae in an osseous shadow indicate that the bone formation results from an avulsion fracture, and is not due to ossification of the ligament. There seems no justification for naming ossification of the ligaments "osteo-arthritis", as is not infrequently done.

In some of the roentgenograms showing droplet formation, there is quite a space between the droplets and the medial epicondyle. In some cases there is sufficient evidence to show that periosteum has been torn off. However, the case of a man, aged thirty-five, affected with *hemophilia* is interesting. He was not aware of any severe injury at any time, but he had had a swollen elbow a number of times. The roentgenogram (Fig. 4) shows the droplet formation.



FIG. 3

Droplet formation of bone in ulnar collateral ligament following dislocation in a male, aged forty-six. The dislocation was reduced on the day of the injury. The roentgenogram shown above was taken three months after injury. Two years after injury the roentgenographic appearance was similar, and the patient had limitation of extension and flexion of 20 degrees in each direction.

In such a case it may be contended that:

1. The ligament has been split in the length of its fibers by injury;
2. Blood has run down between strands of the ligament;
3. Bone cells have been carried by the blood from a torn periosteum at the epicondyle;
4. The tiny hematomata have become isolated and ossification has occurred in each.

On the other hand, ligaments do not tear into shreds very easily, except by severe trauma; the condition is rare in other parts of the body and this sequence of events seems improbable in the hemophilic joint.

Another change in this region is of interest—namely, calcification. The author is indebted to Mr. H. A. T. Fairbank for Figure 5; he recognized an area of calcification, not ossification, adjacent to the lateral epicondyle. This area may be formed in the muscle attachment and may be similar to that occurring in the tendon of the supraspinatus and in the tendo achillis.

## SYMPTOMS

The existence of large plaques of bone produces stiffness. If the elbow is put at rest as soon as ossification is recognized, the condition may not be painful. Small fragments usually cause slight stiffness and

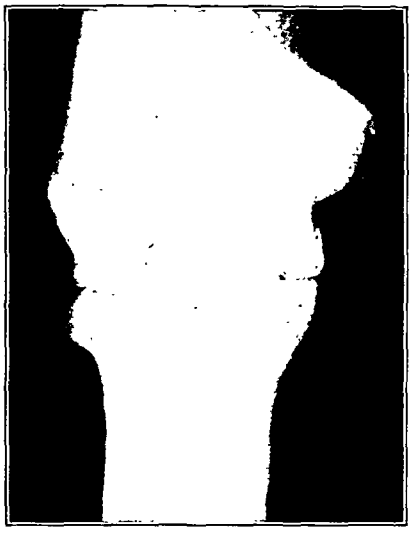


FIG. 4

*Droplet formation of bone in ulnar collateral ligament in a hemophilic joint in a male, aged thirty-five.*

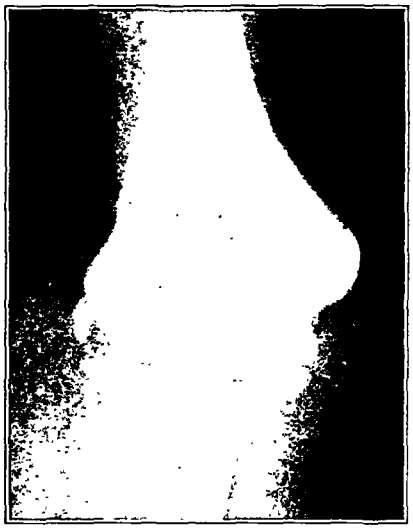


FIG. 5

*Area of calcification adjacent to right lateral epicondyle in a female, aged thirty-five. The patient gave a history of injury to the right or left elbow. When seen there was acute pain and swelling in the outer side of the right elbow joint. The temperature was 100 degrees. Movements were painful in the extremes, but not obstructed. The acute condition had subsided under antiphlogistin.*

may produce limitation of movement, or there may be no symptoms at all.

When there is a piece of displaced bone as well as ossification in the ligament, the limited movement is dependent on the former.

## CAUSATION

There is ample evidence that myositis ossificans will not form unless two factors—traumatic and mechanical—are brought into action.[5] As the latter is avoidable by putting the limb at rest, one would suppose that myositis ossificans need never occur. However, this is not the case with mild degrees of ossification of ligaments. Gross changes, and probably an increase in the extent of ossification, are the result of forced movement or massage, but not the cause of small areas of bone formation. Hence, the gross changes will be prevented by immobilization.

It is recognized that subperiosteal new bone formation may occur on the fibula in cases of osteomyelitis of the tibia; this is supposed to be due to oedema which raises the fibular periosteum. If oedema affects the ligaments, it will facilitate bone formation if bone cells are present, but in the droplet type of case their presence can be accounted for only by shredding of the ligaments, when a hematoma is probably present.

In the cases which the author has examined, small areas of ossification were as frequent when the dislocation had been reduced within a few hours as they were after twenty-four hours. In most of the cases almost immediate reduction was carried out, so theoretically the periosteum or

bone fragments had been replaced. It may be contended that the ossification seen in some of the roentgenograms is in the aponeurosis of the common flexors. This tissue is somewhat like ligamentous tissue, and formation of bone in the tissue will be of comparable origin.

## TREATMENT

These points are raised in order to arrive at the correct *preventive treatment.* Immobilization limits excessive bone formation and is, therefore, advisable. Movement and massage are harmful. Fixation is usually carried out over too short a period; a period of from ten to fourteen days does not allow time for the absorption of blood and the healing of the ligaments. Healing certainly requires three weeks and longer in cases where much swelling and bruising are present. There is no evidence that immediate and complete immobilization has any effect on the formation of small plaques of bone.

When it is recognized that ossification exists in muscle around the elbow, it is fortunate that absorption—partial or complete—will occur if the part is immobilized.

As a rule, once bone is formed in ligament, it remains unchanged. Possibly the ligaments are too avascular to carry out the process of absorption. Rarely, the joint may subsequently undergo the changes of traumatic osteo-arthritis, but this may be the result of the primary injury rather than of the ligamentous injury. When the osseous formation is small and the period of treatment of the primary lesion has been completed, it is best to leave the condition untreated, especially in cases showing droplet formation. In severe cases, it is advisable to put the part at rest in order that the oedema may subside, and localization and consolidation of the bone may occur; if muscle is also implicated, such a line of treatment is rational. Then plaques can be removed or a more extensive operation such as arthroplasty can be planned to regain movement. (See Figure 2-B.)

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# AN OPERATION FOR THE CORRECTION OF HAMMER-TOE AND CLAW-TOE *

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In this paper the treatment of the entities known as hammer-toe and claw-toe will be considered together, because from the standpoint of treatment the deformity is very similar, although it is in a milder form in claw-toe as a rule. Hammer-toe commonly occurs singly in one or both feet, the second toe being most frequently affected. Claw-toe is usually bilateral, the deformity being present in all the digits. However, varying degrees of the deformity may occur in any number of toes. In this condition, the structural abnormalities which require correction are as follows: dorsiflexion contraction of the metatarsophalangeal joint, plantar-flexion contraction of the proximal interphalangeal joint, and plantar-flexion or dorsiflexion contraction of the distal interphalangeal joint. The extensor and flexor tendons show a contracture of their muscles, while there is shortening of the ligaments, skin, and other soft parts in the concavity of the flexures.

Theoretically, the spike operation of Higgs seems to be an improvement on all prior operations and to offer a rational procedure to overcome this deformity. However, it presents technical difficulties which will be mentioned. In this operation, after a transverse incision has been made, the head of the proximal phalanx is shaped with bone forceps so that it resembles a pointed spike. The cartilage is removed from the base of the intermediate phalanx "and a hole is bored up into the shaft of the bone. . . . The pointed first phalanx is then spiked into the second phalanx." The difficulty here is the fact that the head and distal end of a phalanx are made up of cancellous bone, a very thin cortex, and cartilage. When the head is shaped to resemble a spike, the cartilage and cortex are removed, leaving the fragile cancellous bone which is easily broken when it is thrust into the intermediate phalanx. The spiked end cannot be impacted firmly and will rock in its new position, so that it is difficult to splint to prevent displacement or fracture of the spiked end of the first phalanx during the healing process.

An operation which appears to be satisfactory was worked out independently by the writer without knowledge of the Higgs operation. Through a very short linear incision over the dorsal aspect of the metatarsophalangeal joint, a tenotomy of the long and short extensor tendons is performed after they have been hooked up into the wound. In severe cases it is necessary to incise a tight fibrous band which extends across the

* Read at the Meeting of the Western Orthopaedic Association, Seattle, Washington, July 30, 1937.

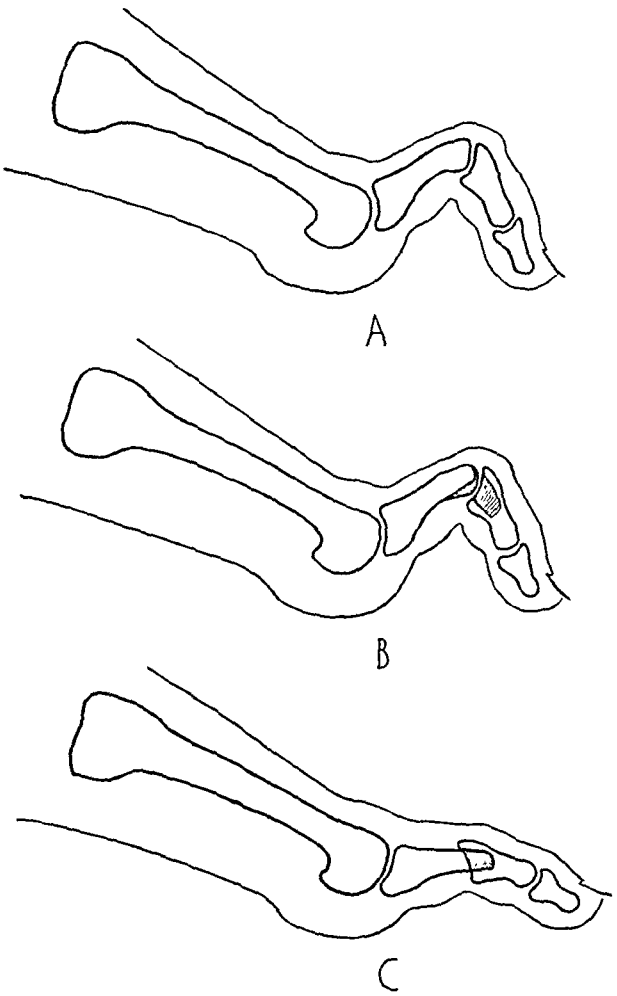



FIG. 1

*A:* Lateral view of the bones in a hammer-toe.
*B:* The head and distal extremity of the proximal phalanx are reshaped to resemble a truncated cone. Attention is called to the intact central part of the dorsal cortex. The cavity made in the base of the second phalanx is represented by the shaded area.
*C:* The distal extremity of the proximal phalanx is fitted into the base of the second phalanx.

dorsum of the metatarsophalangeal joint. In the operation on the toe itself, a linear incision is made over the dorsal surface of the proximal interphalangeal joint, lateral or medial to the extensor tendon to avoid the danger of cutting both dorsal digital arteries, which is frequently done when the transverse incision is used. The digital artery in the line of the incision is sought and ligated with triple 0 plain catgut, if it is found to be injured. The expansion of the long extensor tendon is exposed and divided transversely one-half a centimeter proximal to the joint. The distal end is reflected forward to expose the joint surfaces. The distal extremity of the proximal phalanx is dissected free from the collateral and plantar ligaments and other structures to expose the head and part of the shaft of the bone. By means of small dental rongeur forceps, the cartilage is excised from the head of the phalanx, and the end of the bone is reshaped to resemble a truncated cone. However, it is important not to remove all of the dorsal cortex, because the central part of it is necessary to maintain the required strength of the bone. A drill hole is made in the middle of the joint surface of the base of the second phalanx to penetrate the marrow cavity. This hole is gently enlarged with a very small gouge, and sufficient bone and marrow are excised to make a cavity the size and shape of the new form of the distal end of the first phalanx. The latter is fitted firmly into this cavity, the connection being similar to that by which the sections of a trout pole are joined. Care must be used not to have a rotation of the second phalanx on the proximal phalanx in this union of the two phalanges. The extensor-tendon expansion is united with a mattress suture of silk after a small section of it has been excised to take up the slack in its length. The skin closure is done with silk sutures, and im-

mobilization is maintained with metal or molded plaster splints. A splint is advisable because, on recovering from the anaesthetic or at other times, the patient may inadvertently contract the flexor digitorum longus muscle forcibly and disturb the position of the phalanges. We allow our patients to walk three weeks after operation, but the author believes that in some cases this time can be lessened.

This hammer-toe operation has been performed on the interphalangeal joint of the great toe in one case of claw-toe, and the result was satisfactory.

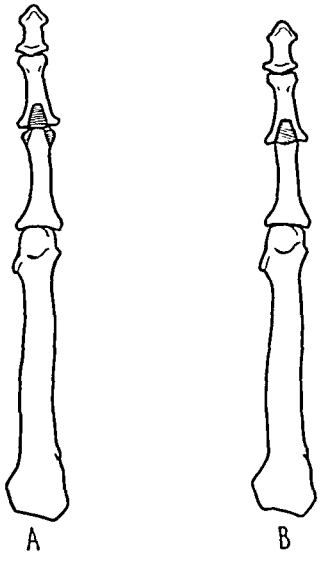



FIG. 2

*A:* Diagram illustrating the reshaped distal extremity of the proximal phalanx and the cavity made in the base of the second phalanx of a hammer-toe, seen from the dorsal aspect.

*B:* Dorsal view of the proximal and second phalanges as fitted together by the arthrodesis.

## COMMENT

In severe cases of dorsiflexion contraction of the metatarsophalangeal joint, the extensor digitorum longus tendon is displaced from its normal position as the dorsal part of the joint capsule and lies subcutaneously. The band of fibrous tissue which must be incised in these cases extends across the joint on its dorsal aspect to close the capsule. In order to expose this band and to avoid injury to vessels and nerves, excellent retraction can be obtained through a short incision by inserting straight Kelly forceps through the subcutaneous tissues to the joint, where the blades are opened and spread so that one blade is placed on each side of the joint.

The shortening of the toe by this operative procedure is not greater than that produced by other arthrodesing operations. However, this shortening, which is usually about five or six millimeters, is equivalent to lengthening the soft parts distal to the metatarsophalangeal joint. This assists in overcoming the flexion contraction of the proximal interphalangeal joint where the flexor digitorum longus tendon, the plantar ligament, and the skin are the most resistant structures. The shortening of the phalanges also makes the expansion of the extensor digitorum longus tendon redundant, because this tendon is inserted into the proximal phalanx and, therefore, the slack cannot be taken up by retraction of the extensor muscles. This makes it necessary to excise a short section of the expansion of the extensor tendon as described.

In some cases of severe deformity, it is advisable to perform the operation in two stages. The arthrodesis of the proximal interphalangeal joint may be performed primarily. The resulting ankylosis provides stability in the toe, so that pressure on its dorsal surface will maintain correction

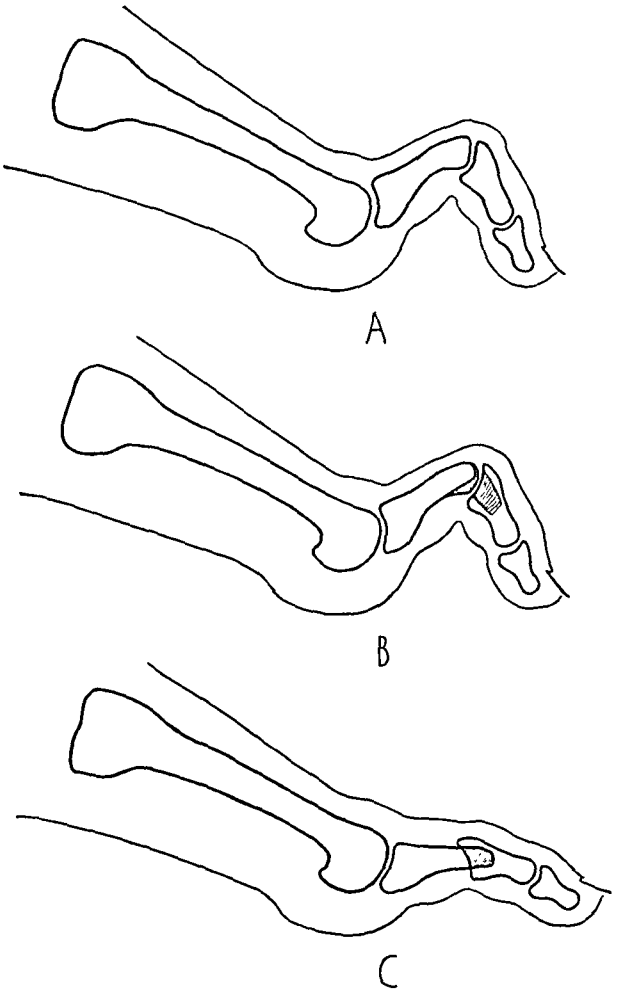



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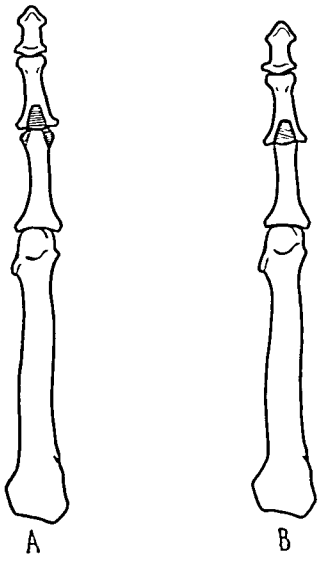



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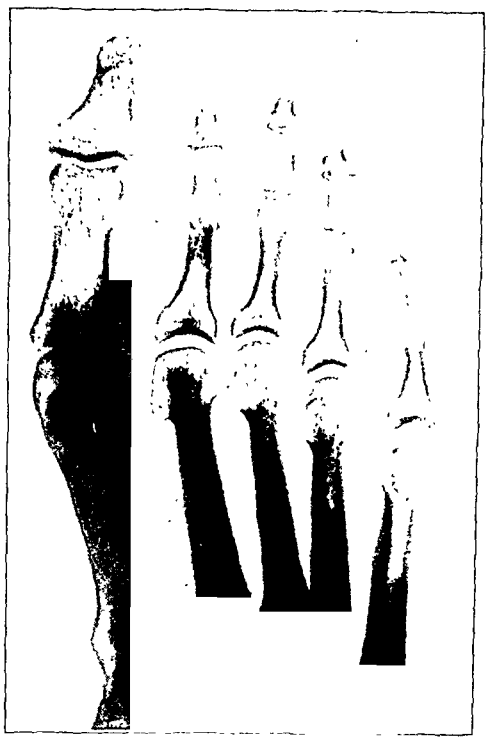


FIG. 3

J. K. Illustrative case of hammer-toe, showing arthrodesis of the proximal interphalangeal joint of the right second toe, nine months after operation.

In this common type of hammer-toe, as well as in claw-toe deformity, there is an assurance of ankylosis.

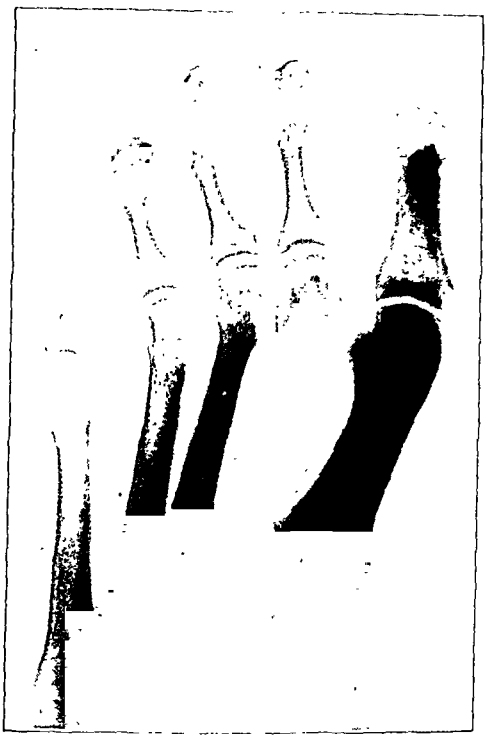


FIG. 4

R. O. Illustrative case of claw-toe, three months after arthrodesis of the interphalangeal joint of the great toe and proximal interphalangeal joints of the second and third toes. The distal half of the proximal phalanx of the fifth toe has been excised. No operation was performed on the fourth toe.

during healing after the tenotomy of the extensor tendons and division of the fibrous band over the metatarsophalangeal joint.

### FIFTH-TOE DEFORMITIES

Claw-toe deformity of the fifth toe presents a different problem, and the operation as outlined does not apply to it, because the second phalanx (or fused second and distal phalanges) is too small to be used for such an operation. For the same reason, no arthrodesing operation is practical on the fifth toe. Amputation in these cases is recommended by most textbooks as the only means of cure for the deformity and relief from painful keratoses. However, amputation is a mutilating procedure, and the writer has been using another operation for several years.

A linear incision is made on the mediodorsal aspect of the fifth toe from a point one-half a centimeter distal to the head of the proximal phalanx to a point one-half a centimeter proximal to the metatarsophalangeal joint. The extensor tendon is tenotomized over the metatarsophalangeal joint to diminish the dorsiflexion contraction. The expansion of the tendon is also tenotomized one-half a centimeter proximal to the head of the proximal phalanx, and its distal end is reflected forward to expose the joint. The distal extremity of the proximal phalanx is dis-

sected free from ligaments, and the soft structures are reflected from the shaft extraperiosteally. The head and distal fourth, half, or two-thirds of this phalanx are excised with bone-cutting forceps, the amount of excised bone depending on the size of the toe or the severity of the deformity. The extensor-tendon expansion is united with a mattress suture.

The fifth toe will be flail following this procedure, but this is no particular disadvantage, because, although shortened, this toe is maintained in its position against the fourth toe, and the patients do not complain. In some cases where the fifth toe is in an extreme dorsal position, it is necessary to perform a plastic lengthening of the skin posterior to it by making a V incision and suturing it as a Y.

Keratoses on the medial aspect of the fifth toe and on the lateral side of the fourth toe are caused by compression of the skin and friction between the head of the proximal phalanx of the fifth toe and the base or shaft of the proximal phalanx of the fourth toe. The operation as described will relieve these keratoses as well as those on the lateral aspect of the fifth toe.

## CONCLUSIONS

1. Hammer-toe and claw-toe deformities are treated most satisfactorily by lengthening the contracted soft structures and by performing an arthrodesis on the proximal interphalangeal joint.

2. An arthrodesis is assured by reshaping the head and distal extremity of the proximal phalanx to resemble a truncated cone and fitting it into a cavity of like shape in the base of the second phalanx.

3. Claw-toe deformity of the fifth toe is not amenable to treatment by an arthrodesing operation, but the deformity and keratoses may be relieved by excision of the head and a portion of the shaft of the proximal phalanx.

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FIG. 5
Chronic bursitis of the knee joint (× 515).

edge of the synovial membrane where the stain appears to be the most concentrated. (Those tissues which had apparently been subjected to rough handling following excision and which had been the victims of a long period of fixation in formalin did not show this phenomenon very clearly. This fact will have to be kept in mind whenever future studies are made.) Second, the appearance of synovial cells which were stained for mucin was different from that of the typical mucin-producing epithe-

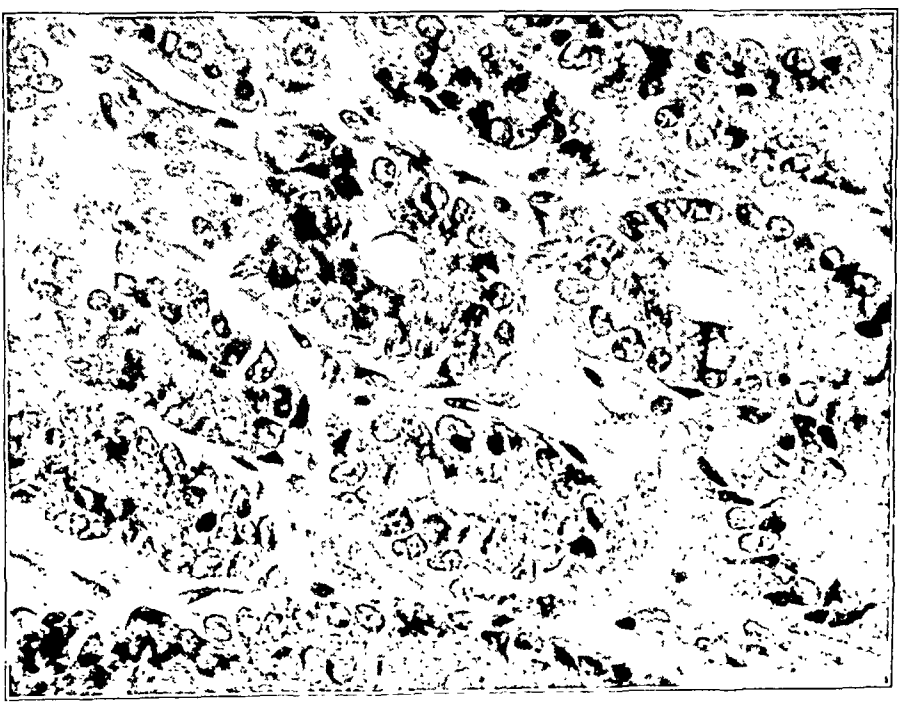


FIG. 6
Section of a normal human stomach (× 430).

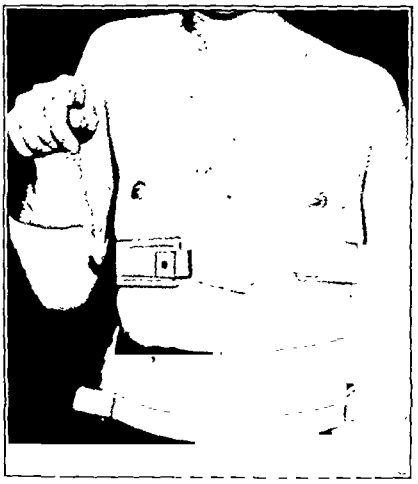


FIG. 1-A

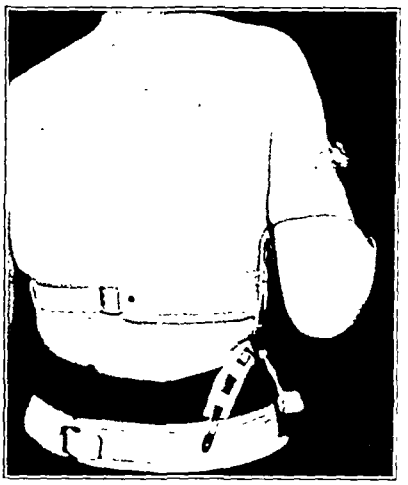


FIG. 1-B

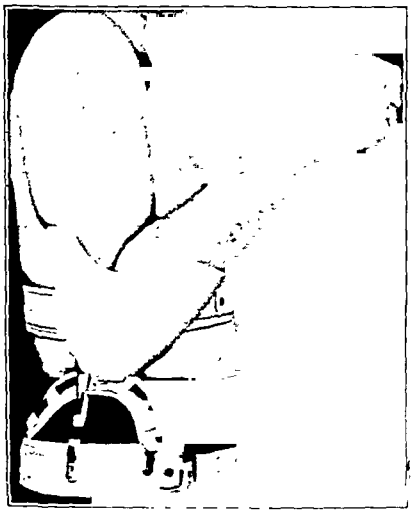


FIG. 1-C

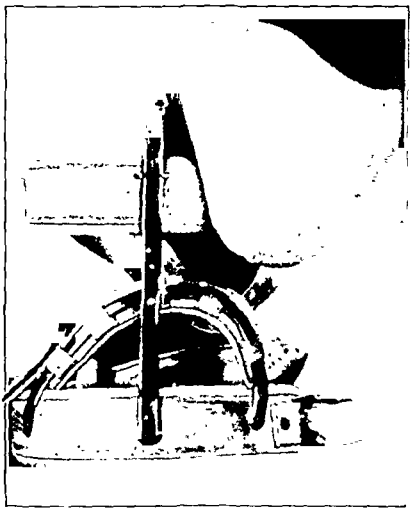


FIG. 1-D

Figs. 1-A, 1-B, 1-C: Showing the upward and backward thrust of the shoulder girdle by the brace described in the text.
Fig. 1-D: Illustrating the celluloid elbow rest, the adjustable steel upright, the chest band, and the pelvic band with the iliac-crest piece.

posterior portion of the deltoid muscle. The patient was instructed to sleep on the abdomen. Local heat and electrical stimulation were administered, and a brace (Figs. 1-A, 1-B, 1-C, and 1-D) was applied. This treatment resulted in early subsidence of acute manifestations and complete recovery in one month.

CASE 4. C. W., a white male, aged thirty-seven, injured his right shoulder in a direct fall, and experienced pain and tenderness in the right scapular region of several weeks' duration. Roentgenographic examination of the affected shoulder was negative. He was seen by one of us in March 1938, eight months after injury, complaining of weakness in the power of the muscles of the right arm and shoulder girdle. Examination revealed a paralysis of the right serratus anterior muscle and weakness of the posterior part of the deltoid; this was corroborated by electrical studies. The patient is responding favorably to our treatment.

# ISOLATED PARALYSIS OF THE SERRATUS ANTERIOR (MAGNUS) MUSCLE*

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In 1825, Velpeau described a case of winged scapula attributable to paralysis of the serratus anterior (magnus) muscle, and since then over 150 cases have been reported. It is believed that most cases are due to injury or to disease of the long thoracic nerve rather than to laceration of the muscle itself, in the absence of such local findings as muscle tenderness, swelling, and ecchymosis. Only one author (Fitchet) claims to have been able to palpate a hiatus between what he interpreted as the retracted portion of the muscle and the scapular border.

Four cases of localized paralysis of the serratus anterior are herein presented, and two additional cases are briefly alluded to.

CASE 1. H. C., a white male, aged thirty-five, severely wrenched his right shoulder in hoisting a 250-pound load on September 6, 1929. He experienced immediate and thereafter constant pain in the region of the right shoulder, and was unable to elevate the right arm above the horizontal plane. He was seen by one of us in May 1930, after having received varied treatment without benefit. Examination at this time showed tenderness in the region of the coracoid process, of the superior internal angle, and of the vertebral border of the scapula; drooping of the right shoulder girdle; weakness and limitation of active abduction to 20 degrees below the horizontal plane; and marked winging of the right scapula. Roentgenographic examination of the right shoulder was negative. Electrical stimulation revealed paralysis of the serratus anterior muscle, and weakness of the middle portion of the trapezius and of the posterior portion of the deltoid muscles.

The patient's response to local heat, galvanic stimulation, massage, and a supportive brace (Figs. 1-A, 1-B, 1-C, and 1-D) was striking, a complete cure being effected in six months. Nocturnal discomfort was eliminated early in the treatment by avoidance of the supine position.

CASE 2. M. B., a white male, aged thirty-five, noted the onset of pain and tenderness in the region of the right shoulder, associated with winging of the right scapula, in August 1930, following overexertion in several strenuous tennis matches and occurring during an attack of conjunctivitis. The diagnosis of localized paralysis of the serratus anterior muscle was corroborated by electrical-reaction studies, and the patient experienced gradual recovery following self-imposed exercises. Roentgenographic examination of the shoulder was negative.

Examination by one of us in April 1931 revealed drooping of the right shoulder and residual winging of the scapula. The patient was advised to assume the prone posture in sleeping, to institute electrical stimulation, and to continue with his exercises. The patient reported complete recovery in June 1931.

CASE 3. S. J., a white male, aged thirty-nine, was seen in July 1937, complaining of pain in the region of the right shoulder of one week's duration, occurring during a severe head cold and following the bearing of 200-pound loads on the right shoulder for several days. Examination revealed localized tenderness in the region of the coracoid process and definite winging of the right scapula. Roentgenographic examination of the cervical spine and shoulder was negative. Electrical stimulation elicited a weakened response from the right serratus anterior muscle, the mid-portion of the trapezius muscle, and the

*This study has been partly aided by a grant from the J. Ewings Mear Research Fund, Jefferson Medical College, Philadelphia.

possible, and the forearm extended and supinated. The weight of the forearm and hand is transmitted through the biceps and coracobrachialis muscles to the coracoid process and supraglenoidal tubercle, pulling the outer portion of the scapula downward and forward, while the vertebral border and superior internal angle are tilted upward, backward, and medialward by the levator scapulae and rhomboidei muscles. The disappearance of winging by the motion of flexion of the forearm is evidence that the biceps muscle, rather than the deltoid, is responsible for this deformity.

Secondary contraction of the biceps and coracobrachialis muscles in long-standing paralysis of their antagonist, the serratus anterior, must be overcome. This was demonstrated in Case 1 by (1) the complaint of the patient early in treatment of a "tearing sensation" in the elbow region near the biceps insertion, and (2) the fact that, early in the treatment, abduction above the horizontal plane was secured only with the elbow flexed about 150 degrees, but, following further recovery, abduction was restored with wider extension angles of the elbow joint.

The triceps muscle, antagonistic to biceps function, is the protagonist of the serratus anterior and, when the latter is paralyzed, becomes stretched. This becomes evident, as the serratus recovers and once more rotates the scapula, by (1) the relative weakness of extension of the elbow joint, and (2) the appearance of the triceps belly which hangs loosely when the arm is abducted 90 degrees and the elbow is fully extended.

Secondary stretching of the middle and lower portions of the trapezius, with pronounced shoulder drop, occurs early, as noted in all of our cases. Abduction to within the horizontal plane by the deltoid muscle is impaired by the absence of scapular fixation, and becomes further weakened by the secondary stretching of the posterior part of the deltoid.

## TREATMENT

All exciting, contributing, and perpetuating factors—focal and systemic infection, intoxications, postural compression, occupation, and strenuous use of the affected extremity—must be treated or eliminated. The physiological balance of the shoulder must be restored by treatment with the recommended brace, physical therapy, massage, electrical stimulation (applied critically and accurately, so that only the paralyzed muscle and its stretched protagonists are stimulated), and guided exercises.

Loss of tonicity of the serratus anterior results in a medial, upward, and backward shift of the vertebral scapular border and its inferior angle, and a downward and forward displacement of the acromion process. It follows that, to relax a paralyzed serratus anterior muscle, the scapula must be *dcrotated*, and this is best accomplished by the apparatus illustrated in Figures 1-A, 1-B, 1-C, and 1-D. The adjustable elbow rest, made of celluloid or light metal, forces the humeral head upward and backward, and, through the latter's ligamentous attachments, the acromion, glenoid fossa, and coracoid process are also elevated. Full support is maintained through the pelvis alone, thus avoiding traction straps over

CASE 5*. A white male, aged fifty-five, had a localized paralysis of the right serratus anterior muscle with winging of the scapula, which had occurred during an attack of influenza. The upper scapular region was swollen and extremely tender to pressure. The patient was treated with rest and physical therapy for six months. At the end of two years a slight weakness of the serratus anterior muscle persists.

CASE 6*. A white male, aged thirty-five, suffered a localized paralysis of the left serratus anterior muscle, following a severe blow to the left scapular region in an automobile accident. He experienced immediate pain, swelling, and tenderness in the region of the left shoulder, and shortly thereafter he noted winging of the left scapula. Slight weakness of the serratus anterior still persists one year and three months after injury.

## PATHOGENESIS

Trauma (direct or indirect, acute or chronic) to the neck, shoulder, or scapula regions is a primary etiological factor. The occurrence of paralysis during infections and the presence of systemic and local manifestations are indicative of an infectious factor.

The results of a study by the authors of 100 anatomical specimens, to be published in a separate communication, are briefly:

1. A likely site for localized injury to the long thoracic nerve, following its complete formation, is where it courses between the coracoid process and the lateral costal cage (second rib). In addition, the nerve is found to become definitely angulated as it crosses the second rib and its overlying heavy musculature. A downward thrust of the shoulder girdle, or a lateral tilt of the head and neck in the opposite direction, places the nerve on stretch and increases its angulation over the second rib.

2. Morphological variations in the formation and the course of the long thoracic nerve are influential, and serve to explain why identical traumata in different individuals only infrequently result in this lesion.

3. Four bursae—the subcoracoid, the subscapular, the accessory subscapular, and the supracoracoid—are adjacent to the nerve. If these normal bursae, or adventitious bursae which develop as a result of occupation (Torraca), become enlarged due to trauma, to infection, or to both, they may exert a direct mechanical (pressure) effect on the nerve, or the nerve may become inflamed by contiguity.

4. These factors are all exaggerated by the supine posture, and one can readily associate the effect of nocturnal compression on our patients and the permanent relief experienced by them upon assuming the prone or contralateral side position in sleeping. The reported occurrences of paralysis of the serratus anterior in prolonged obstetrical and surgical cases, and in those long bedridden (Bertrand and Chailly; Thorek; Tavernier; Guillain and Libert; Berkheiser and Shapiro), may be explained in part by the mechanical insult of the supine position.

## KINESIOLOGICAL OBSERVATIONS

"Winging" of the scapula becomes most evident with the patient erect, the arm forward flexed to the horizontal plane or abducted as far as

*Presented by courtesy of Dr. John A. Brooke, of Philadelphia.

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the shoulders. Slight external rotation of the arm, in addition to its backward thrust, may be necessary to approximate closely the scapula to the chest wall. The position advocated accomplishes the following:

1. It removes the weight of the extremity from the shoulder;
2. It derotates the scapula, relaxing the paralyzed serratus anterior and the stretched muscles and overcoming the contracted ones.
3. The effect of the biceps muscle on the scapula is eliminated by flexion of the elbow joint.
4. The pain of an associated bursitis or neuritis is relieved by immobilization.

Suspension of the arm by the wrist with a sling about the neck (Mackenzie), a direct pressure pad over the scapula (Thomson and Miles), the airplane brace (Fitchet), or plaster fixation with the arm abducted and externally rotated 90 degrees (Berkheiser and Shapiro), while they serve to relax the serratus anterior and to eliminate winging, fail to derotate the scapula properly and, thereby, to overcome the secondarily stretched and contracted muscles.

## CONCLUSIONS

1. Anatomical studies indicate that the coracoid process of the scapula, the second rib, and certain related scapular bursae, as well as morphological variations in the formation and course of the long thoracic nerve, play significant rôles in the pathogenesis of localized paralysis of the serratus anterior muscle. Postural compression of the long thoracic nerve must be allowed a part as an exciting or perpetuating factor.

2. The biceps brachii, as a strong antagonist of the serratus anterior, is a leading factor in the production of the classic "winged scapula". The shoulder drop seen in cases of serratus-anterior paralysis, is a result of stretching of the middle and lower portions of the trapezius muscle, while weakening of abduction power is due in part to stretching of the posterior portion of the deltoid muscle.

3. Relaxation of the paralyzed serratus anterior muscle and correction of the associated stretched and contracted muscles are secured by eliminating both the winging and the abnormal rotation of the scapula, and this is effectively performed by the brace illustrated. This apparatus is also recommended in the treatment of brachial-plexus neuritis, and has been successfully employed in cases with cervical-rib or scalenus-anterior syndromes.

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the two joints indicated accomplishes the same mechanical purpose in these cases.[2] If the equinus is marked and the wedge to be removed is necessarily large, it is preferable to take most of it from the navicular and to spare the head of the talus. The cosmetic result is better and it is equally effective. The foot is then brought into the corrected position by apposing the newly created denuded surfaces. The ligament, capsule, and periosteum are sewed with No. 2 chromicized catgut; the subcutaneous tissues, with No. 2 plain catgut; and the skin, with silk or dermol.

A plaster-of-Paris boot is applied from the toes to the knee with the foot held at a right angle to the leg and in slight adduction or abduction, depending upon the original deformity. During the application of the plaster, while it is still soft, the longitudinal arch is molded by hand. This gives a form to the arch which will be preserved more or less by subsequent fusion. An incidental advantage of tarsal-wedge arthrodesis is manifest at this point. The possibility that the foot may slip during the application of plaster is not as great a hazard as in certain other operations on the tarsus, since during the entire procedure the foot can be remolded by hand without reopening the wound. The importance of any single internal retention suture is minimal. The newly apposed bone surfaces are flat, and, if placed in position with reasonable accuracy, will overcome any slight diathesis during the process of fusion. The plaster is maintained for twelve weeks. It may be changed during that time, but it is best to leave the original plaster boot on for at least four weeks.

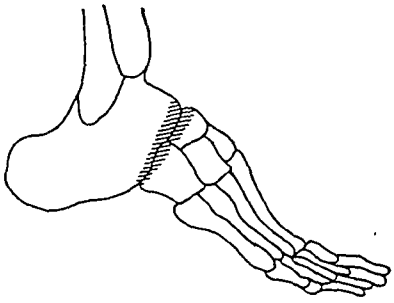


FIG. 2

The shaded area shows the simple design of the wedge and the arthrodesis.

## PREOPERATIVE CARE

A factor which should be obvious, but too often is neglected, is that the less the extent of resection necessary to correct deformity, the more stable and more cosmetic the final result. To this end, the author recommends preliminary correction of marked deformity to an optimal position by non-traumatizing measures. For this purpose, the repeated plaster technique for the correction of severe club-foot, as described by Kite, has been found most suitable. Forcible correction by means of apparatus of the "wrench" type is to be deprecated. In cases where a marked cavus element accompanies a varus or equinus deformity, a preliminary release of the plantar fascia, according to the technique of Steindler, has considerably reduced the deformity and thereby minimized the necessity for extensive resection of the tarsal bones.

# TARSAL-WEDGE ARTHRODESIS

BY EDGAR M. BICK, M.D., NEW YORK, N. Y.

*From the Hospital for Joint Diseases * and Mt. Sinai Hospital*

Tarsal-wedge arthrodesis has been used in recent years to correct a variety of foot deformities. On the services with which the present author is associated, it has rapidly displaced several of the more extensive procedures heretofore considered standard in orthopaedic literature. Although no essential originality can be claimed for the operation, it has been developed and modified from its surgical forebears until at present it is a well-defined technique. Its advantages are relative simplicity, wide adaptability, and the excellence of the functional, as well as the cosmetic, result. It is physiologically rational.

## TECHNIQUE

The operation is best performed under tourniquet. The author prefers two small incisions,—one longitudinal on the mid-dorsum, exposing the talonavicular joint; and a second on the lateral surface of the foot, exposing the calcaneocuboid articulation. (See Figure 1.) However, a single incision from below the external malleolus, running upward and forward to the mid-dorsal line about two fingerbreadths below the ankle joint, also gives adequate exposure. In both cases the exposed tendons are gently retracted, and the underlying membrane of the ligament, capsule, and periosteum is incised and elevated as a unit, bringing the articulation and adjacent bone into view. Next, a wedge-shaped piece of bone is marked out at the site indicated by the deformity. When an equinus deformity is to be corrected, the wedge is removed from both sides of the talonavicular joint, and includes the articulating surfaces. Thereafter the calcaneocuboid joint is denuded of its cartilage and placed in position for fusion. (See Figure 2.) When a varus deformity is to be corrected, the wedge is taken from the calcaneocuboid joint, with its base placed laterally, and a simple arthrodesis is performed at the talonavicular joint. It should be noted here that a wedge arthrodesis of one of these areas without arthrodesis of the other is not dependable. In several instances where this was tried, secondary deformity occurred. In the most common type of deformity, both equinus and varus deformities are present, and wedges must be removed from the talonavicular and calcaneocuboid articulations. It is not necessary to fuse the subtalar joint, since fusion of



FIG. 1

The two heavy lines show the incisions preferred by the author. The dotted line indicates the alternate single incision.

* Service of Samuel Kleinberg, M.D.

lium of the stomach. While the synovial membrane took the stain more or less uniformly throughout the cell and intracellular substance, the gastric cells were stained in an uneven manner in the cellular cytoplasm.

Kernohan was of the opinion that the mucin, together with the other substances of the synovial fluid, is produced by a "myxomatous degeneration" of the cells of the membrane about which there is a rather constant lymph stasis. The factors of trauma, motion, and weight-bearing of the joints are added. This is closely akin to Frerichs' original theory of "mucoid degeneration".

The purpose of this paper is not to consider the source of the synovial fluid as a whole, but to attempt to demonstrate the source of mucin, which is the most important substance in maintaining the proper lubrication of the joints. However, we might venture the suggestion that the composite synovial fluid seems to be the result of a combination of mechanisms rather than of any single one. It would appear that it is a diffusate to which have been added mucoproteins and other proteins in a manner as demonstrated by this paper.

We adhere to that opinion in general acceptance today in regard to the embryonic nature of the synovial cells,—namely, that they are derived from the mesenchyme.

## SUMMARY AND CONCLUSIONS

A review of the current literature shows that the nature of the synovial cells and the mechanism of the production of the synovial fluid are still subject to controversy.

The importance of first solving these problems concerning the cytology and physiology of the synovial membrane before further progress can be expected in the study of diseased joints is emphasized.

By using excised portions of synovial membrane obtained from joints, bursae, tenovaginal sheaths, and tendon ganglia, the presence of mucin was demonstrated within the synovial cells.

Studies of these sections lead one to believe that the mucin within the synovial fluid is a product of synovial-cell degeneration.

Adherence to the general opinion that the synovial cells are of connective-tissue origin is acknowledged.

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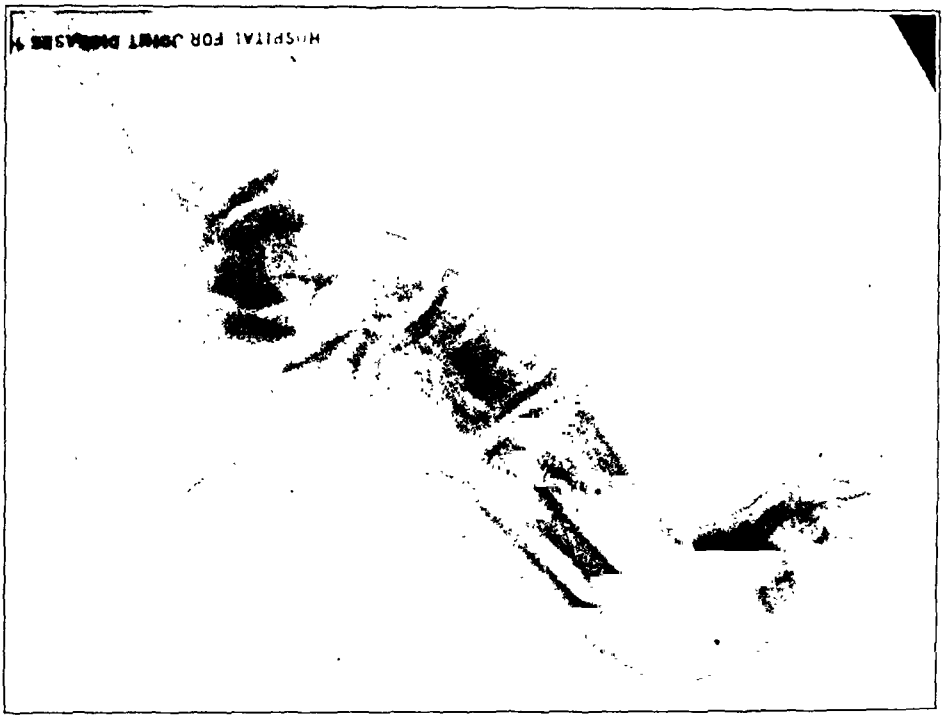


FIG. 3-A
V. L. Before operation.

## INDICATIONS

Tarsal-wedge arthrodesis is indicated in a variety of foot deformities. In the present series of cases it has been used successfully for the following: equinovarus, varus, equinocavus, cavus, equinovalgus, and abduction of the forefoot (post-traumatic).

The pathology or, rather, pathogenesis of the deformity plays no part in determining the efficacy of the operation. The deformities of these feet are either congenital or the result of poliomyelitis, spastic paralysis, Friedreich's ataxia (cavus), suppuration, or fracture. The excellence or failure of the end result could in no statistical fashion be related to the cause of the deformity. The operation is designed to correct a static anatomical malposition of the tarsus.

## CONTRA-INDICATIONS

Only two contra-indications are important. The first is imperative,—namely, the presence of an active lesion of the central nervous system. Tarsal-wedge arthrodesis should not be performed in such a case, since the subsequent progress of the disease leads to secondary deformity.

The second important contra-indication for tarsal-wedge arthrodesis is a very young patient. The minimal age at which tarsal arthrodesis is possible has been a moot question for years. In the present investigation, however, this has become secondary to a more pertinent observation. It is not a question of the age at which tarsal bones may be surgically fused, but at what age can arthrodesis be performed without subsequent secondary deformity of associated structures due to continued abnormal



Fig. 3-B
V. L. After operation.

growth of the foot. In a series of thirty-five cases of tarsal arthrodeses of various types in which adequate follow-up data were available, only two out of eight patients operated upon under the age of ten years could be said to have good results. In the other cases of this age group, secondary deformities supervened, requiring further correction. In the present series of fifteen tarsal-wedge arthrodeses, only three were performed on patients ten years or younger, because of the previous experiences noted. In one of these, the end result was good; in one, fair; in the other, bad. In general, tarsal arthrodesis in children ten years of age or younger must be considered undependable in spite of an occasional success.

## END RESULTS

Of the fifteen patients operated upon and followed for a significant period of time (thirteen from one to five years and two for six months) good results were obtained in all but one. The one failure was a case of post-suppurative deformity in which insufficient correction was obtained because of preexisting fusions of associated joints in the foot, due to the original lesion. In one of the successful cases, a preceding tendon transplantation had been performed, which, in all fairness, had improved the function of the foot. It was further considerably improved by a tarsal-wedge arthrodesis. In two other cases, the operation, while correcting the deformity of the tarsus and function of the foot as a unit, did not correct preexisting "claw" toes. These were corrected by a subsequent operation.

In brief, when tarsal-wedge arthrodesis is performed in properly selected cases, it is found to be a mechanically sound procedure. Only one failure in fifteen cases is recorded, and that failure was due to an error in judgment for which the operation *per se* cannot be held at fault.

## DISCUSSION

It has not been the author's purpose in this report to describe a new operation for deformities of the feet. He has reason to know that of these there are already more than enough. The object has been to urge the use of a procedure for which a simple standard technique has been developed and which has proved successful in a variety of foot deformities. The technique, which the author has termed the "tarsal-wedge arthrodesis", has the following advantages which entitle it to wide popularity:

1. It is simple to perform, and it allows for secondary improvement in position after closure of the wound.

2. It disturbs the internal architecture of the tarsus less than other operations requiring more extensive bone trauma. It, therefore, does not compromise the appearance of the foot to the same degree.

3. It has been almost uniformly successful in properly selected cases, and its indications include a number of the most common foot deformities. Hence it extends the adaptability of a simple procedure at the expense of a variety of more complicated ones.

The author wishes to thank Dr. Kleinberg, Dr. Selig, and Dr. Lippmann for permission to study cases on the Service, in which the operations were not performed by the author.

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# HEMANGIOMATA OF THE LOWER EXTREMITIES

## With Special Reference to Those of the Knee-Joint Capsule and the Phenomenon of Spontaneous Obliteration

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The primary occurrence of hemangiomata in practically all tissues and organs of the body except the hair and the nails has been reported. This paper is limited to a discussion of those hemangiomata arising from the deeper tissues of the leg and not those of cutaneous origin. These tumors are of interest because they occur more frequently and are more painful and disabling than those in other localities within the scope of orthopaedic surgery. Although often easily eradicated by surgery, they frequently cause years of suffering to the patient, due to lack of prompt recognition.

There is no sharply defined criterion as to the composition of hemangiomata. In this presentation, mainly cavernous hemangiomata are considered. These are tumors composed of large, irregularly shaped spaces filled with normal blood and separated by a connective-tissue septum. The blood spaces lack the definite walls of normal blood vessels, and may or may not have an endothelial lining (Fig. 1). Phleboliths are occasionally present. These tumors are frequently invasive, although benign in character. Metastatic hemangiomata have been reported (Hall, Jaffe, Markowitz, and Shennan) but this phenomenon is sometimes questioned.

The following five cases of hemangioma, which have come under the author's personal observation, are presented as typical of the condition.

Case 1. Cavernous hemangioma of the popliteal vein.

*Clinical History:* A man, aged twenty-seven years, was admitted to the University of Kansas Hospital on February 1, 1929. Ten years previously, and without apparent cause, soreness had been noticed in the left popliteal space. The pain had soon become sharp, although periodic in character, and gradually had become more intense. One year after onset the patient had begun to limp, and this had become more pronounced with time. Three weeks previous to admission a friend had "kneed" him in the left popliteal space. The patient had had immediate terrific pain in the area of the blow, causing him to fall to the floor, from which he had been unable to rise. He was carried home where a physician administered a hypodermic of one-fourth of a grain of morphine sulphate, with little if any effect upon the pain. At the end of about twelve hours, the pain had begun to subside, and after three days the patient attempted to return to work. However, he was so uncomfortable that he reported to the Hospital for aid.

*Examination:* The left leg showed moderate atrophy of the thigh and the calf. The knee lacked about 15 degrees of complete extension. A soft nodular tumor, about the size of a hazel nut, exquisitely tender to pressure, was palpated in the outer half of the popliteal space. The skin was freely movable over the mass and was not discolored. There was no pulsation.

*Operation:* On February 5, 1929, an operation was performed by the author, and a

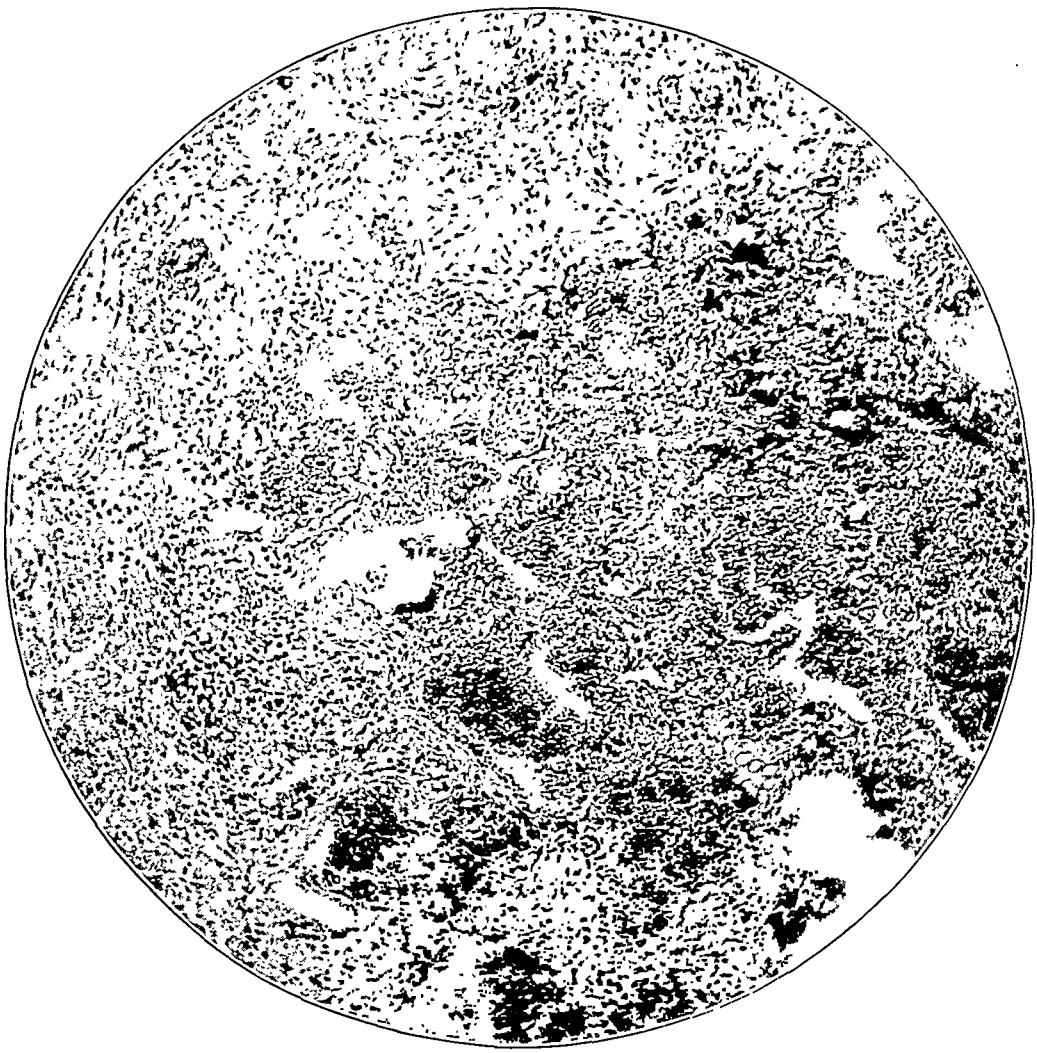


FIG. 1

Photomicrograph of histological section of hemangioma (Case 2).

soft, bluish, lobulated tumor was found, which was adherent to the surrounding tissues. The tibial nerve was incorporated in the tumor and was pushed to the outer side of the popliteal space. After the mass was dissected free, it was found to be attached to the popliteal vein by a short vessel. The "stem" was ligated, and the mass was removed.

*Postoperative History:* One month after operation the patient was symptom-free, and there was no tenderness in the popliteal space.

*Histological Report:* "The wall of a large dilated vein is seen, in which there is marked thickening of the intima. In some places the vessel wall is broken down and surrounded by a rather vascular and cellular wall resembling cellular granulation tissue. There are no leukocytes, but many fibroblasts and young capillaries are seen. Other portions are typical of the blood spaces of a cavernous angioma."

CASE 2. Cavernous hemangioma of the capsule of the knee joint.

*Clinical History:* A girl, aged fifteen years, was admitted to the University of Kansas Hospital on May 6, 1929. At the age of five years she had fallen, striking the right knee on a "foot scraper". This had caused a slight laceration over the area of the anterior and inferior border of the medial condyle of the femur, which had healed promptly, but this area had been exceedingly sensitive to a blow or pressure ever since. The patient had had frequent "attacks" of pain in the knee, which had lasted from a few minutes to several weeks, usually occurring after a blow on the knee, or when arising from a sitting

posture. The knee had frequently "given way" although locking had never occurred. At the age of eleven years, the right leg had been encased in a plaster-of-Paris bandage for a period of four months, which had given relief from pain while it was worn and for several months thereafter. Three months previous to admission the patient had had scarlet fever and immediately thereafter the knee became so painful that she was unable to attend school.

*Examination:* The right leg was three-fourths of an inch shorter than the left, and the right thigh presented two and three-fourths inches of atrophy, and the right calf one and one-fourth inches of atrophy. Active motion at the knee joint was moderately painful, with restriction of extension. There was marked tenderness on pressure throughout a small area over the lower border and anterior aspect of the medial condyle of the femur. There was no palpable tumor.

*Operation:* On May 7, 1929, an operation was performed by Dr. C. B. Francisco, and a small mass of fibrous tissue and dilated veins (thirty by twenty by ten millimeters) was found lying on and attached to the capsule of the knee joint, at the area of tenderness. This mass was excised without opening the capsule.

*Postoperative History:* A letter, dated April 5, 1933, stated that the patient had been symptom-free since the operation, but she still had the same amount of shortening although much less atrophy of the thigh and the calf.

*Histological Report:* "A typical picture of a cavernous hemangioma."

CASE 3. Cavernous hemangioma of the extensor digitorum brevis muscle.

*Clinical History:* A girl, aged ten years, was admitted to the University of Kansas Hospital on February 23, 1931. Five years previously a flatiron had been dropped upon the dorsum of the patient's right foot. There had been considerable oedema, ecchymosis, and pain immediately following, all of which had disappeared in about ten days. A small subcutaneous nodule had remained at the site of injury. There had been no further symptoms until three years later, when the small tumor had become sensitive to pressure. Since the onset of tenderness, the tumor had gradually increased in size. It was exceedingly painful if struck and had become so sensitive to pressure that a shoe could not be worn.

*Examination:* There was no atrophy of the thigh or the calf, and no limited or painful motion was noted at any of the joints. There was a small, elongated, easily compressible, and exceedingly tender tumor on the dorsolateral aspect of the right foot. The skin over the tumor had a bluish tinge, but was freely movable.

*Operation:* On February 25, 1931, an operation was performed by Dr. C. B. Francisco. A small bulging mass of blood vessels was found in the extensor digitorum brevis muscle. The tumor, with a portion of the muscle, was excised.

*Postoperative History:* On February 29, 1933, the patient was readmitted to the hospital with a recurrence of the tumor. The tumor was excised more widely this time, but two years later there was another recurrence and a third excision was done elsewhere. The patient was symptom-free on January 1, 1937.

*Histological Report:* "A typical picture of a cavernous hemangioma."

CASE 4. Cavernous hemangioma of the vastus lateralis muscle.

*Clinical History:* A man, aged twenty years, was seen at the University of Kansas Hospital on January 18, 1933. He complained of pain and weakness in the left leg, which had been present ever since he had had diphtheria at the age of twelve years. Since the onset there had been a small area of tenderness on the lateral surface of the thigh just above the knee. Even the lightest of blows on the tender area caused excruciating pain, the patient almost passing into a condition of shock. For six months previous to admission, he had been unable to walk more than one or two blocks at a time because of pain and weakness in the leg.

*Examination:* There was atrophy of the left thigh amounting to two and one-half inches and atrophy of the left calf amounting to two inches. (See Figure 2.) The hip, knee, and ankle joints presented no limitation of motion. There was a small subcuta-

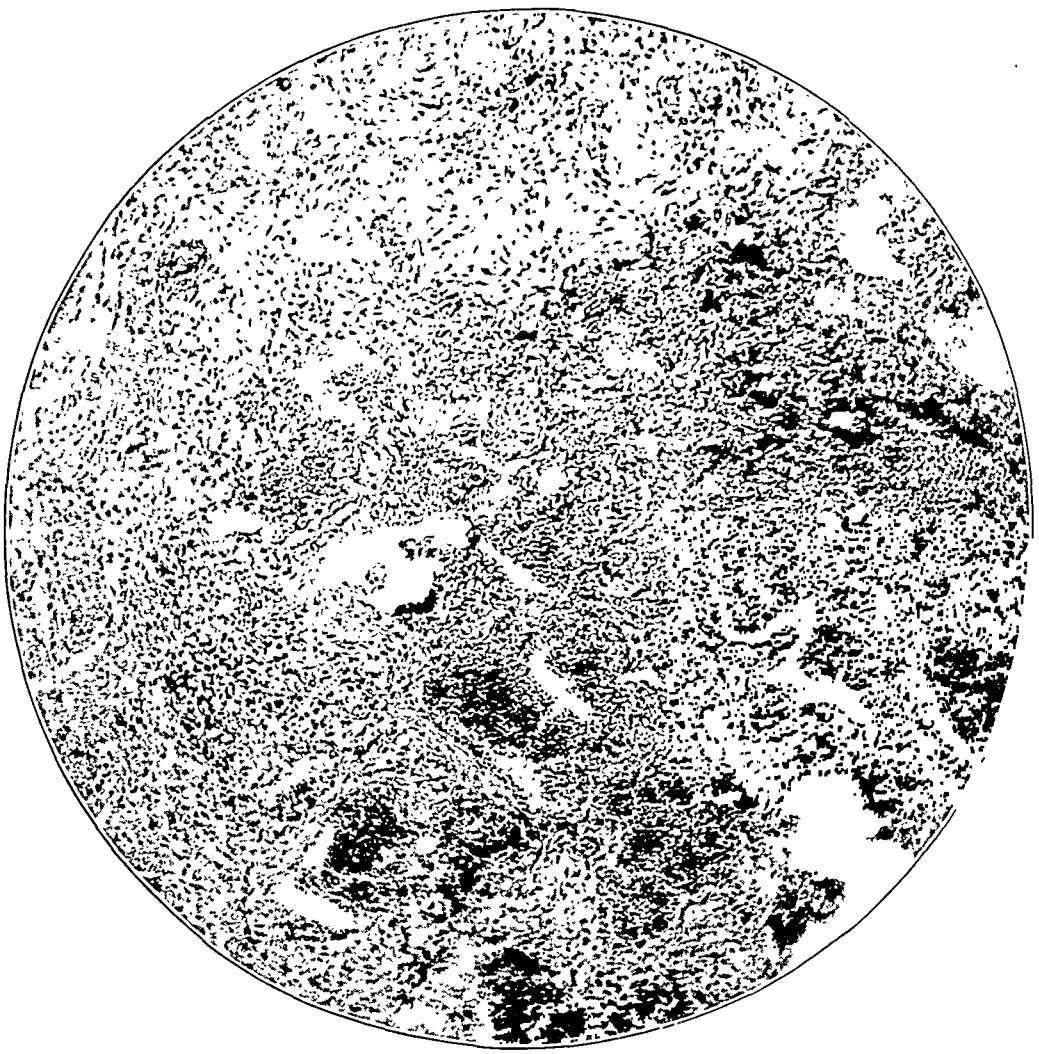


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posture. The knee had frequently "given way" although locking had never occurred. At the age of eleven years, the right leg had been encased in a plaster-of-Paris bandage for a period of four months, which had given relief from pain while it was worn and for several months thereafter. Three months previous to admission the patient had had scarlet fever and immediately thereafter the knee became so painful that she was unable to attend school.

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CASE 4. Cavernous hemangioma of the vastus lateralis muscle.

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*Examination:* There was atrophy of the left thigh amounting to two and one-half inches and atrophy of the left calf amounting to two inches. (See Figure 2.) The hip, knee, and ankle joints presented no limitation of motion. There was a small subcuta-

neous nodule palpable just above the lateral condyle of the knee. The skin was not attached to the tumor, which was so tender to palpation that nothing further could be determined by touch. Roentgenographic examination of the area was negative.

*Operation:* On January 23, 1933, an operation was performed by the author, and a small mass of veins about the size of a pea was found imbedded in the vastus lateralis muscle and excised.

*Postoperative History:* In a few weeks' time the patient was working on a farm. On June 15, 1936, he stated that he had remained entirely symptom-free and that his legs were practically the same size.

*Histological Report:* "A typical cavernous hemangioma with considerable lipomatosis and inflammatory reaction."

CASE 5. Obliterated hemangioma of vastus lateralis muscle, with phlebolith.

*Clinical History:* A girl, thirteen years old, was admitted to the University of Kansas Hospital on April 28, 1928, complaining of an extremely sensitive area on the lateral surface of the left knee. Six or seven years before admission she had frequently complained of pain in the left knee after a day of hard play. There had been no further complaints until three years later, when a left limp had developed and the patient had begun to complain, if touched or struck on the outer surface of the left knee. The limp had persisted and the tenderness had increased. She ran and played, but screamed with pain from the lightest of blows upon the outer surface of the left knee.

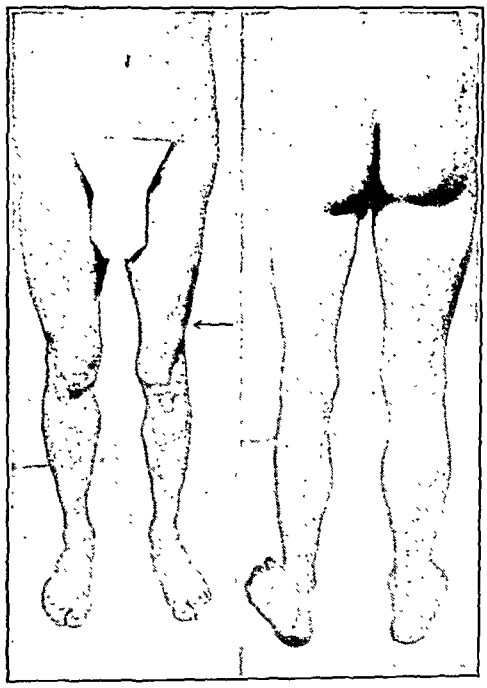


FIG. 2

Photograph of patient in Case 4 showing marked atrophy of the left leg. The arrow indicates the location of the tumor.

*Examination:* The left leg presented atrophy of one and one-quarter inches in both the thigh and the calf. Extension at the knee was limited to 160 degrees and flexion to 85 degrees. Motion at the knee was not painful. Roentgenograms showed a calcified nodule about the size and shape of a small pea, situated at the side of the lateral condyle and in the soft tissues.

*Operation:* On April 29, 1928, an operation was performed by Dr. C. B. Francisco. Deep in the vastus lateralis muscle was found a calcareous deposit in a mass of small threadlike tendrils. The mass was excised.

*Postoperative History:* On March 24, 1935, her family physician reported: "She has had no recurrence and no pain. Motion is perfect."

*Histological Report:* "Section shows several masses of hyaline fibrous tissue markedly infiltrated with mononuclear leukocytes. Embedded in these leukocytic foci are peculiar dark-blue-staining bodies suggesting typical calcareous masses. Some multinucleated giant cells are seen around these. There is considerable fat tissue and at one side are a few small blood spaces separated by hyaline fibrous tissue."

In the foregoing cases striated muscle is involved three times, the capsule of the knee joint and the popliteal vein once each.

The literature in regard to hemangiomata of striated muscle has been reviewed in two excellent papers. In 1929 Davis and Kitlowski reported 201 cases, and added eleven new cases. Six of these had been

previously reported by Davis. In 1932 Jenkins and Delaney again reviewed the literature, excluded eighteen cases reported by Davis and Kitlowski, found sixty-one others, and added one of their own,—a total of 256. The distribution of these lesions was as follows: lower extremity, 107; upper extremity, sixty-four; head, neck, and trunk, eighty-four; and one unclassified.

Since the cases in this report are not confined to striated muscle, a search of the literature was made to ascertain the frequency of occurrence in other tissues of the leg. The case reports so found, excluding those in this paper, total thirty-three as summarized in Table I. With the addition of 104 * cases of hemangioma of striated muscle previously mentioned and the five cases reported in this paper, there is a grand total of 142. Undoubtedly some reports have escaped the author's attention, and unquestionably many cases have not been reported or have not been recognized, so it seems reasonable to assume that the condition is not rare, and is probably of more frequent occurrence than is generally realized.

The distribution of hemangiomata in various tissues of the leg in these 142 cases is indicated in Table II. The part primarily involved is recorded as definitely as possible, although in some instances this was impossible, as several structures were involved by the one process. The relative frequency with which the capsule of the knee joint is involved is quite striking when one compares the bulk of this structure to that of the muscles of the leg. The explanation of this phenomenon, in the author's opinion, is found in the rich blood supply of the capsule plus its liability to trauma.

In Figure 3 the regional distribution is indicated. The data concerning the buttocks and the foot are exact, while those of other areas are approximate. In many instances the lesion overlapped the arbitrarily defined areas, while in others the exact location was not clear from the case reports. The figures are considered to be correct within the limit of 10 per cent. of error. It is of interest that a large percentage of tumors occur in rather close proximity to the knee joint.

The etiology of hemangiomata is unknown. Most authors accept the theory of a congenital anomaly, with trauma frequently playing a rôle in the development of the tumor and its symptoms. This is no doubt correct in many cases, yet there is much evidence that the principal etiological factor in a moderate number of cases is injury. This fact has been emphasized by Mailer, who reported a case of traumatic hemangioma of muscle. In support of the congenital theory is the unassailable fact that some of these tumors are present at birth. Additional evidence brought forward is that 80 per cent. of hemangiomata make their appearance before the twenty-first year and that they are found in tissues not readily

* Three cases, operated upon by Eve, reported by Hilgenberg, and summarized by Davis and Kitlowski as arising in muscle, are considered by us to have arisen in the knee-joint capsule (synovia) and are so listed in Table I. Thus there are 104 cases of hemangiomata arising in muscle, instead of 107 as previously mentioned.

TABLE I

SUMMARY OF THIRTY-THREE CASES OF HEMANGIOMA OF THE LEG

| Case No. | Author and (Surgeon) | Sex | Age (*Years*) | History | Clinical Findings | Operative Findings and Result | Pathology |
|---|---|---|---|---|---|---|---|
| | | | | CAPSULE OF THE KNEE JOINT | | | |
| 1 | E. S. Bastos | Male | 39 | Difference in size of knees noted since birth. At age of 10, right knee became painful after running a race. Size of knee and severity of pain increased with time. | Knee joint contained bloody fluid. A spongy, compressible tumor the size of an orange was palpated. Pressure evoked intense pain. | Tumor arising from capsule. Excision. Partial synovectomy. Recovery. | Typical cavernous hemangioma. |
| 2 | R. Bertelsmann | Female | 27 | Pain in knee at age of 15, with remissions. At age of 22, knee became so painful from blow and use that patient could not bear weight. | No hydrops. Flexion of knee or light pressure to inner border of patella produced severe pain and caused patient to cry out. | Small tumor embedded in thickened capsule. Excision. Recovery. | Hemangioma with round-cell infiltration and areas of chronic inflammation. |
| 3 | E. Bouchut | Female | 3 | Undernourished child. | Soft elastic tumor on inner aspect of knee. Skin normal. Aspiration yielded blood. | Patient died of "exhausting diarrhoea". Autopsy revealed angioma of capsule, extending into knee joint. | Resembled tissue of corpus cavernosum or sponge filled with blood. No microscopic examination. |
| 4 | Oswald Duda | Male | 18 | Pain and stiffness in left knee 4 weeks previous to observation. | Tumor size of pigeon's egg at outer margin of patella. No functional impairment. | Tumor arising from inner capsule (synovia). Excision. | Cavernous hemangioma. Phleboliths. |
| 5 | H. Eggers | Female | 18 | In 1914, 1918, and 1923, patient reported with hydrops. Plaster casts and hot-air treatment gave relief. Aspiration in 1923 yielded blood. In 1927 small, painful tumor found at puncture site. No other injury. | Atrophy of quadriceps and limited motion of knee joint. Tumor size of small saucer in upper outer quadrant of knee. Pain disappeared on elevation of foot. Area tender. | Tumor on outer capsule. Excision revealed another tumor size of dollar on inner surface of capsule. Two tumors were connected. Recovery. | Cavernous hemangioma. No histological examination. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | Alfred Haas | Male | 30 | Pain and swelling of right knee at age of 5. Treated to tenth year by casts, with remissions. Remission until seventeenth year, when there was marked hydrops with pain. Marked pain and swelling on slight trauma or use. | Hydrops of right knee. Slight flexion contracture. Flexion painful. No circumscribed tumor. Varicosities in popliteal space. | Tumor mass filled joint and covered entire synovia and cartilage. Synovectomy. Well for 2 years; then recurrence. At age of 30 patient requested relief at any price. Excision of knee joint. Angiomatous masses extended into head of tibia. | Capillary hemangioma of synovial membrane. |
| 7 | Alfred Haas | Female | 22 | From birth, several small red tumors present just below popliteal space. Ten years previous to examination, a small tumor had been noted just above patella. Was painful on kneeling. Excised 5 years later. Recurred and became very painful. | Atrophy of left thigh. No hydrops. Small, very tender, and freely movable mass just above patella. Several bean-sized cutaneous angiomata present. | A tumor the size of a pigeon's egg invaginating the inner surface of the capsule. Partial synovectomy. Recovery. | Considerable fat and fibrous tissue surrounding a cavernous hemangioma. |
| 8 | F. C. Hilgenberg (Eve) | | 15 | Swelling size of pea on outer portion of knee. Gradually increased in size to that of a hen's egg. Later, great pain. No apparent cause. | | Angioma beginning in synovial membrane. Excision. Recovery. | Cavernous hemangioma. |
| 9 | F. C. Hilgenberg (Eve) | | 10 | Pain in left knee of 4 to 5 years' duration, without apparent cause. Increase of pain and disability. | Oedema of inner border of patella. Increased heat after exercise. Skin normal. | Small tumor on inner surface of synovial membrane. Excision. Recovery. | Cavernous hemangioma. |
| 10 | F. C. Hilgenberg (Eve) | Female | | Young woman with history similar to that of Case 8. | | Angioma of upper recesses of synovial membrane, extending into surrounding muscles. Excision. End result unknown. | Cavernous hemangioma. |

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| 7 | Alfred Haas | Female | 22 | From birth, several small red tumors present just below popliteal space. Ten years previous to examination, a small tumor had been noted just above patella. Was painful on kneeling. Excised 5 years later. Recurred and became very painful. | Atrophy of left thigh. No hydrops. Small, very tender, and freely movable mass just above patella. Several bean-sized cutaneous angiomata present. | A tumor the size of a pigeon's egg invaginating the inner surface of the capsule. Partial synovectomy. Recovery. | Considerable fat and fibrous tissue surrounding a cavernous hemangioma. |
| 8 | F. C. Hilgenberg (Eve) | | 15 | Swelling size of pea on outer portion of knee. Gradually increased in size to that of a hen's egg. Later, great pain. No apparent cause. | | Angioma beginning in synovial membrane. Excision. Recovery. | Cavernous hemangioma. |
| 9 | F. C. Hilgenberg (Eve) | | 10 | Pain in left knee of 4 to 5 years' duration, without apparent cause. Increase of pain and disability. | Oedema of inner border of patella. Increased heat after exercise. Skin normal. | Small tumor on inner surface of synovial membrane. Excision. Recovery. | Cavernous hemangioma. |
| 10 | F. C. Hilgenberg (Eve) | Female | | Young woman with history similar to that of Case 8. | | Angioma of upper recesses of synovial membrane, extending into surrounding muscles. Excision. End result unknown. | Cavernous hemangioma. |

TABLE I

SUMMARY OF THIRTY-THREE CASES OF HEMANGIOMA OF THE LEG

| Case No. | Author and (Surgeon) | Sex | Age (*Years*) | History | Clinical Findings | Operative Findings and Result | Pathology |
|---|---|---|---|---|---|---|---|
| | | | | CAPSULE OF THE KNEE JOINT | | | |
| 1 | E. S. Bastos | Male | 39 | Difference in size of knees noted since birth. At age of 10, right knee became painful after running a race. Size of knee and severity of pain increased with time. | Knee joint contained bloody fluid. A spongy, compressible tumor the size of an orange was palpated. Pressure evoked intense pain. | Tumor arising from capsule. Excision. Partial synovectomy. Recovery. | Typical cavernous hemangioma. |
| 2 | R. Bertelsmann | Female | 27 | Pain in knee at age of 15, with remissions. At age of 22, knee became so painful from blow and use that patient could not bear weight. | No hydrops. Flexion of knee or light pressure to inner border of patella produced severe pain and caused patient to cry out. | Small tumor embedded in thickened capsule. Excision. Recovery. | Hemangioma with round-cell infiltration and areas of chronic inflammation. |
| 3 | E. Bouchut | Female | 3 | Undernourished child. | Soft elastic tumor on inner aspect of knee. Skin normal. Aspiration yielded blood. | Patient died of "exhausting diarrhoea". Autopsy revealed angioma of capsule, extending into knee joint. | Resembled tissue of corpus cavernosum or sponge filled with blood. No microscopic examination. |
| 4 | Oswald Duda | Male | 18 | Pain and stiffness in left knee 4 weeks previous to observation. | Tumor size of pigeon's egg at outer margin of patella. No functional impairment. | Tumor arising from inner capsule (synovia). Excision. | Cavernous hemangioma. Phleboliths. |
| 5 | H. Eggers | Female | 18 | In 1914, 1918, and 1923, patient reported with hydrops. Plaster casts and hot-air treatment gave relief. Aspiration in 1923 yielded blood. In 1927 small, painful tumor found at puncture site. No other injury. | Atrophy of quadriceps and limited motion of knee joint. Tumor size of small saucer in upper outer quadrant of knee. Pain disappeared on elevation of foot. Area tender. | Tumor on outer capsule. Excision revealed another tumor size of dollar on inner surface of capsule. Two tumors were connected. Recovery. | Cavernous hemangioma. No histological examination. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16 | G. B. Lauwers | Male | 30 | One year previously, while climbing a ladder, patient had slipped, striking knee. Painful for 2 years; then worse. Could walk only 1½ hours daily. Some days bedridden. | Some hydrops. Motion of knee limited and painful. Atrophy of thigh and calf. Very tender spot, 3 by 4 centimeters, in upper outer quadrant of knee. | Small tumor beneath fascia and in the capsule. Excision. Recovery. | Angiofibroma. |
| 17 | J. T. O'Ferrall | Male | 19 | Slight injury to right knee joint 5½ years previously. Slight swelling and pain. Localized swelling on outer border of knee cap for 2 years. Mass very tender. Slight trauma caused such severe pain patient could hardly walk. | Mass over external aspect of knee size and shape of terminal phalanx of thumb. Very tender. Atrophy of thigh and calf. Full extension. Flexion limited. | Mass in anterior chamber of knee, arising from synovial membrane at head of tibia, excised with portion of joint capsule. Limp after 16 months, with 25 degrees of flexion. No recurrence. | Cavernous hemangioma. |
| 18 | J. T. O'Ferrall (G. A. Caldwell) | Female | 20 | At age of 2 years, patient fell, striking right knee which became swollen and tender. At age of 8, right knee struck with baseball bat. Patient was unable to walk for several months. Slight to severe pain persisted. At age of 16, patient became entirely disabled. | Extension complete but painful. Flexion limited to 90 degrees. No hydrops. Mass over outer margin of patella and extending to lower third of thigh. Mass markedly tender. X-ray negative. | Mass of small veins arising from joint reflections and extending under quadriceps. Small section removed. Second operation revealed a mass from epiphyseal line of femur to junction of middle and lower thirds of thigh. Ten months later, no recurrence. | Hemangioma. |
| 19 | Reichel and C. Nauwerck | Male | 18 | Pain and swelling of right knee at age of 16. No apparent cause. Patient in bed 8 weeks at onset; then worked up to 1 month before entering hospital. | Knee swollen. Motion slightly restricted. Serous fluid obtained on aspiration. Later, tumor size of pigeon's egg noted on inner border of patella. Not painful on pressure. | Tumor found embedded in synovia. Partial synovectomy. Knee remained slightly restricted in motion. | Cavernous hemangioma. |

TABLE I (*Continued*)

SUMMARY OF THIRTY-THREE CASES OF HEMANGIOMA OF THE LEG

| Case No. | Author and (Surgeon) | Sex | Age (*Years*) | History | Clinical Findings | Operative Findings and Result | Pathology |
|---|---|---|---|---|---|---|---|
| 11 | F. C. Hilgenberg (Seidener) | Male | 37 | Injured knee in fall 2 years previously. Pain and oedema after 2 years. Oedema would appear suddenly and remain 8 to 14 days. Patient unable to walk at time of examination. | Oedema of knee. Tumor size of hen's egg between head of fibula and tuberosity of tibia. Skin and joint motion normal. Aspiration yielded blood. | Extrafascial tumor excised and a second tumor found on inner surface of synovial membrane. This tumor also excised. Patient able to work, but motion of knee joint limited. | First tumor, fibrolipoma. Second tumor, pigmented hemangioma of joint capsule. |
| 12 | F. C. Hilgenberg (Zesas) | | 25 | Pain in knee for 1 year. No trauma. Recurrent swelling. Patient never entirely free from pain. | Slight contracture of knee. Motion painful. Slight amount of fluid. A small, soft tumor on inner side of patella, disappearing on pressure. | Extensive tumor continuous over joint capsule with processes branching into muscle. Partial synovectomy. Recovery with fair motion. | Cavernous hemangioma. |
| 13 | F. C. Hilgenberg (Oeser) | Male | 33 | Since youth, periodic painful swelling of right knee, without cause. Usually appeared a few minutes after slight trauma. Greatest pain on walking. | Fluctuant swelling almost the size of a hen's egg on the inner side of knee above patella. Muscles atrophic. Motion free. | Tumor removed from inner side of joint capsule. Patient free from pain after operation. Almost complete motion. | Cavernous hemangioma combined with a papilloma. |
| 14 | F. C. Hilgenberg (Müller) | | 17 | Pain in right knee for 2 years. | Region of inner epicondyle somewhat swollen and tender. | Tumor size of pea on medial aspect of joint capsule. Excision. Recovery. | Hemangioma. |
| 15 | F. C. Hilgenberg (Marburg Surgical Clinic) | Male | 19 | At age of 13, knee injured. After bed rest, patient ambulatory with occasional pain and limitation of motion. Knee again injured at age of 18. Swelling and pain increased until patient was unable to walk. | Tumor size of hen's egg on inferior and outer border of patella; fluctuant and very tender. Motion restricted and painful. | Tumor size of walnut growing through joint capsule. Cavernous process invading joint. Partial synovectomy. Recovery. | Cavernous hemangioma. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | NERVE | | | |
| 25 | F. H. Purcell and E. S. Gurdjian | Female | 1¾ | Tenderness of left buttock at 8 months. At 16 months, plaster hip spica applied because of limp and increasing pain. Cast worn 6 weeks. Improvement for 4 months; then pain recurred. | Fullness of left buttock. Atrophy of thigh and calf. Bandlike resistance at level of trochanter and ischial tuberosity. Tenderness in buttocks. | Dark blue tissue invading sciatic nerve for a distance of 2 inches. Removed. Recovery. | Cavernous hemangioma. |
| 26 | F. H. Purcell and E. S. Gurdjian (Schutze) | | | | Marked tenderness and swelling along course of posterior tibial nerve at ankle. | | Hemangioma. |
| 27 | René Sommer (Lewsden) | Female | 5 | Tumor first noticed as swelling on left heel. No hindrance on running or walking. A few days before patient was seen, tumor became painful to touch. | A very tender tumor deep in tissue over os calcis and between medial malleolus and tendo achillis. Motion of foot and ankle complete and painless. | Tumor about the thickness of the index finger attached to posterior tibial nerve. Shelled out easily. | Encapsulated cavernous hemangioma. |
| 28 | S. F. Stewart and M. E. Bettin | Male | 10 | Lump seen in right lower leg at 10 months. Later, 3 other lumps noted. At 4½ years, increase in size of tumor and in severity of pain. Patient excluded from school because of pain and deformity. | Right knee flexed at 90 degrees. Hip flexed and foot in equinovalgus. Atrophy of foot. Lower belly of gastrocnemius muscle enlarged and also upper part of tendo achillis. Tender to palpation. | Large hemangioma of internal popliteal nerve with multiple angiomata of other branches of sciatic nerve. Amputation above knee. | Hemangioma. |
| | | | | BONE | | | |
| 29 | Rudolf Pohl | Female | 56 | At 53, Pirogoff amputation for "creeping disease" of foot performed. Pain persisted. Three nerve operations performed, with no relief. Proliferation on mid-shin very painful and tender. | Palpable elevation on tibia size of apple. Sharply localized tumor of bone—loss of calcium surrounded by sclerosis. | Amputation at knee. | Cavernous hemangioma. |

TABLE I (*Continued*)

SUMMARY OF THIRTY-THREE CASES OF HEMANGIOMA OF THE LEG

| Case No. | Author and (Surgeon) | Sex | Age (*Years*) | History | Clinical Findings | Operative Findings and Result | Pathology |
|---|---|---|---|---|---|---|---|
| 20 | E. Venezian | Male | 3 | Nine months previously, patient fell and bruised knee. A small tumor appeared. This was quiescent for a time; then patient suffered sudden severe pain and oedema. Slight trauma aggravated the condition. | Knee flexed. Small mass just above head of fibula. Pressure on tumor elicited pain. Exploratory puncture yielded blood. | Angioma of synovia, extending to infrapatellar fat pad. Partial synovectomy. Knee remained slightly restricted in motion. | Cavernous angioma with considerable fat tissue. |
| | | | | TENDON | | | |
| 21 | M. S. Burman and J. E. Milgram (A. Steindler) | Male | | Pain in left knee of 6 years' duration. Mild trauma 2 years previous to onset of symptoms. | Extremely sensitive area just above patella at outer border of quadriceps. Atrophy of thigh. X-ray showed loose bodies in knee joint. | Cirsoid mass external to synovia and arising from quadriceps tendon. Resection of tumor and adjacent tissue. Second operation 3½ years later because of pain. No recurrence. Adhesions freed with care. | Cavernous hemangioma. |
| 22 | M. S. Burman and J. E. Milgram (M. S. Burman) | Female | 7 | Lump on outer side of left leg of 4 years' duration. No increase in size. Lump caused increase in limp already present as result of infantile paralysis. | Tumor, 5 by 4 by 4 centimeters, on lateral aspect of leg 5 inches above ankle. Skin normal. | Angiomatous mass interrupting course of peroneocuboideus tendon. Excision. No recurrence or symptoms 6 months later. | Cavernous hemangioma with no evidence of tendon in center of tumor. |
| 23 | M. S. Burman and J. E. Milgram (Miltner) | Female | 22 | Lump in left popliteal space of 17 months' duration, preceded by general joint pains. Mass fluctuated in size and caused some discomfort. | Tumor size of walnut tender to pressure. | Tumor originating from semitendinosus tendon and attached by a pedicle. Excision. Patient symptom-free 6 months later. | Encapsulated cavernous hemangioma containing much hyalinized fibrous tissue. |
| 24 | M. S. Burman and J. E. Milgram (Wilkie) | Female | 26 | Tumor size of lemon present for 2 years. No pain. | No note. | Mass removed from tendon of plantaris. | Cavernous hemangioma. |

subjected to injury. Since nevi are almost always congenital in origin, association of ideas makes the congenital theory readily acceptable when viewed in conjunction with the foregoing evidence. On the other hand, many of these cases present a clear-cut history of injury followed in a reasonable length of time by the appearance of the tumor, or the symptoms of the same, at the site of trauma. A moderate number appear in middle-aged and elderly patients. It must be remembered that the growth period is the age of most frequent injury, and, as far as the cases in this presentation are concerned, hemangiomata occur in those areas most frequently subjected to injury (Fig. 3). Of the 142 cases in this series, nineteen, or 13.4 per cent., are definitely congenital in origin. In thirty, or 21.1 per cent., there is a definite history of injury followed by the formation of a hemangioma at the site of trauma. In six cases, or 4.2 per cent., there is a history of external injury influencing the course of an existent hemangioma. Of the remaining cases, in twenty-three, or 16.2 per cent., there is a definite statement of no injury; while in sixty-four, or 45.1 per cent., no data were given on this point. It does not seem beyond reason that some error in growth may occur, with the formation of a hemangioma, in the production of new blood vessels in the repair of traumatized tissue. This might be especially true in the presence of a hematoma, according to the theory of Pilzer. Certainly, "traumatic" is a far more applicable descriptive prefix than "congenital" in reference to the author's Cases 2 and 3 of this series and to similar cases.

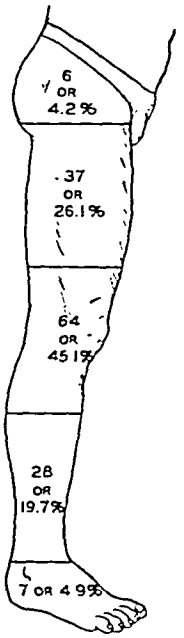



FIG. 3

Regional distribution of hemangiomata in the lower extremity.

Regardless of its rôle as an etiological factor, trauma undoubtedly plays an exceedingly important part in the development of the symptoms of these neoplasms. Trauma may be either internal or external in type, or a combination of the two. Internal trauma is produced by the stress and strain about a weight-bearing joint as well as by muscle relaxation and contraction. This observation is verified by the fact that angiomata occurring about weight-bearing joints are more painful and disabling than those located about non-weight-bearing joints or those situated remotely from a joint (Table III). It is further confirmed by the fact that bed rest relieves pain, and immobilization of the part in a plaster-of-Paris bandage relieves pain not only during the period that the bandage is worn, but also for several weeks or months after its removal (this series: Eggers, Haas, O'Ferrall, Purcell and Gurdjian, and the author's Case 2). Fürnau's patient (case reported by Davis and Kitlowski) had no pain at night, but the application of a cast was followed by severe pain. A cast causing pressure on a hemangioma would undoubtedly produce an increase in the amount of pain, and from the history one suspects such was the case in

TABLE I (*Continued*)

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| Case No. | Author and (Surgeon) | Sex | Age (*Years*) | History | Clinical Findings | Operative Findings and Result | Pathology |
|---|---|---|---|---|---|---|---|
| 30 | M. Van Neck | Female | 56 | In 1927, patient began to have pain in left knee and thigh. In April 1928, pain localized in patella. | No atrophy. No pain on motion. Area painful to pressure. X-ray showed area of destruction size of pea in patella. | Curettement. Immediate relief from pain. | Hemangioma. |
| | | | | VEIN | | | |
| 31 | Samuel Kleinberg | Male | 7 | Swelling of calf of right leg noticed at age of 3 weeks. Gradual increase in size. No symptoms or disability. | Tumor size of orange in right calf superficial to muscle and not attached to skin. No pulsation. Not sensitive to pressure. | Pear-shaped mass,—body above, stem below. Terminated in single vein. Above, tumor continuous with small vein. Excision. Recovery. | Cavernous hemangioma. |
| | | | | INFRAPATELLAR FAT PAD | | | |
| 32 | J. T. O'Ferrall (R. B. Osgood) | Female | 24 | At age of 5, injured right knee. Ever since, patient had limped slightly and had favored knee. At 21 years, moderate pain was present. Any slight blow caused pain. | Atrophy of calf and thigh. Slight flexion. No hydrops. Some puffiness beneath patella; this area very tender. | Tumor size of 25-cent piece with small tablike lobe, arising from infrapatellar fat pad. Excision. Recovery. | Cavernous hemangioma. |
| | | | | PREPATELLAR BURSA | | | |
| 33 | Oswald Duda (Von Ranka) | Female | 24 | Tumor supposed to have followed prepatellar bursitis. | | Hemangioma found on floor of prepatellar bursa. Excision. | Cavernous hemangioma. |

# TENDON TRANSPLANTATION FOR CLAWING OF THE GREAT TOE

BY M. F. FORRESTER-BROWN, M.S., M.D. (LOND.), BATH, ENGLAND

In orthopaedics, as in other branches of surgery, the so-called "minor" disabilities are often the most crippling to the patient and, therefore, "major" to him. One of these, which is common in the late stages of poliomyelitis, as well as in other paralytic conditions, and which has not received from surgeons the attention it deserves, is clawing of the great toe.

The condition is one of plantar flexion of the terminal interphalangeal joint and dorsiflexion of the metatarsophalangeal joint, and each of these joints may reach a stage of irreducible subluxation. This attitude may develop very slowly and insidiously in a foot that appeared normal for a year or more after the acute onset of poliomyelitis, and it is due to minor degrees of faulty balance among the muscles,—that is, weakness of the tibialis anterior associated with overaction of the extensor hallucis longus and flexor hallucis longus, together with weakness of the intrinsic muscles of the foot, especially those acting on the great toe. If the sole muscles are strong, there is usually a cavus deformity of the whole tarsus. The deformity is most liable to occur in the good limb, upon which most of the body weight is borne, due to weakness of the other hip or knee. It is also frequently latent while the patient is at school and is seated a large part of the day, but it develops steadily after he begins work with much standing or walking. Hence its seriousness. What the patient actually complains of is not the deformed appearance, but the corns which occur under the head of the first metatarsal and on the dorsum of the terminal joint. These are likely to be very hard and painful and to resist all the efforts of the chiropodist. When muscle balance is restored by the simple operation to be described, they yield to the simplest measures, such as scrubbing with soda or an application of a salicylic preparation, and they do not recur.

The operation which the author wishes to describe is based on the principle suggested by Sir Harold Stiles[1] during the Great War for the treatment of lumbrical paralysis of the hand,—namely, the creation of an artificial lumbricalis by transferring part of the flexor tendon (flexor digitorum sublimis in the hand) to the extensor tendon opposite the first phalanx, the course normally taken by the lumbricalis, so that it may flex the knuckle and extend the interphalangeal joints.

In the case of the great toe, the present writer began by transferring half of the flexor hallucis longus to a new insertion in the extensor hallucis longus. Later it was found that, if the terminal joint of the toe was subluxated, it was best corrected and fixed by arthrodesis in a straight line. Then it was safe to transfer the whole flexor hallucis longus to the new insertion.

TABLE II

DISTRIBUTION OF HEMANGIOMATA IN THE LEG

| Structures Involved | No. of Cases | Total Cases |
|---|---|---|
| Skeletal muscles: | | |
| Quadriceps femoris | 21 | |
| Gastrocnemius | 17 | |
| Vastus medialis | 15 | |
| Biceps femoris | 10 | |
| Vastus lateralis | 7 | |
| Semimembranosus | 6 | |
| Glutei | 6 | |
| Soleus | 5 | |
| Gracilis | 2 | |
| Semitendinosus | 2 | |
| Miscellaneous and unclassified | 16 | 107 |
| Capsule of knee joint | 21 | 21 |
| Tendons: | | |
| Quadriceps femoris | 1 | |
| Peroneocuboideus | 1 | |
| Semitendinosus | 1 | |
| Plantaris | 1 | 4 |
| Nerves: | | |
| Sciatic | 2 | |
| Posterior tibial | 2 | 4 |
| Bones: | | |
| Patella | 1 | |
| Tibia | 1 | 2 |
| Veins: | | |
| Branch from popliteal | 1 | |
| Vein of calf | 1 | 2 |
| Infrapatellar fat pad | 1 | 1 |
| Prepatellar bursa | 1 | 1 |
| Total | | 142 |

this instance. In numerous cases the tumor gave no symptoms for months or years, but became painful after some major injury or series of minor injuries or after some form of severe physical exercise, such as a foot race (this series: Bastos), jumping (Jenkins and Delaney's series: von Khautz) or dancing (Davis and Kitlowski's Case 10). With rest, the pain disappears to become recurrent upon repeated and less vigorous external trauma or exercise until it eventually becomes so severe that the patient is partially or totally disabled.

Trauma does not necessarily affect the rate of growth of these neoplasms. A hemangioma may pass from the quiescent to the acutely painful stage and an increase in size may or may not follow. As a matter of fact, some of these tumors do not increase in size from the time when they are first noticed through a period of several years.

A lesser factor in the etiology and symptomatology of hemangiomata is disease. In two instances there was an increase in symptoms following scarlet fever (Davis and Kitlowski's Case 2 and the author's Case 2). The tumor was first noticed following diphtheria (the author's Case 4), prepatellar bursitis (this series: Von Ranka), grippe (Davis and Kitlowski's series: Guyot and Jeanneney, and Bénard and Lamy), and appendicitis (Davis and Kitlowski's Case 6). While this phenomenon is rare, it has occurred frequently enough to merit consideration if not emphasis.

The cardinal symptom is pain. This observation has been made by most authors. Davis and Kitlowski, who have had the richest clinical experience, consider pain the chief symptom. Bénard and Lamy believe that the word "*douloureux*" should be added to the name of these tumors. Sommer stated that, due to pain, many of these patients have the appearance of patients suffering from pulmonary tuberculosis. In Kirmisson's case (Davis and Kitlowski's series) a general anaesthetic was required before the tumor could be palpated. Some authors who report a case of non-painful hemangioma do not stress this point. Jenkins and Delaney are frequently quoted as stating that pain was present in 58 per cent. of their cases. This statement is true, but does not tell the complete story and is, therefore, misleading. It would have been equally correct, but also misleading, to state that no pain was present in only 12 per cent. of the cases in the series reported by these authors. As a matter of fact, there was a definite history of pain in 56 per cent. of the cases and of no pain in 12 per cent. There was no statement concerning this point in the remaining 32 per cent. Since many of the cases were reported by non-clinicians and only a meager clinical history, or no clinical history, was given, it does not seem correct to assume that pain was not present in all instances unless a definite statement was made to the contrary. The author knows of no other small benign tumor of a non-vital tissue such as synovia or muscle which can be so excruciatingly painful and completely disabling as a hemangioma. A possible exception is the glomus tumor or arterial angioneuromyoma of Masson, and these neoplasms are a type of hemangioma.

Various theories are advanced as to the mechanism of the production of pain. Spontaneous pain is accepted as the explanation by some authors. Many hemangiomata, especially congenital ones, are symptom-free in the beginning and remain so for several months and as long as sixty years before becoming painful. Certainly spontaneous pain can be ruled out in these cases. Angiolithic concretions are said to cause pain. Any irritative or congestive factor probably does cause pain, but in only a small percentage of hemangiomata are phleboliths present.

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| Sciatic | 2 | |
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| Tibia | 1 | 2 |
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| Infrapatellar fat pad | 1 | 1 |
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TABLE III

STATISTICS IN REGARD TO PAIN

| Series | Lower Extremity | | | | | | Upper Extremity | | | | | | Head, Neck, and Trunk | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pain | | No Pain | | No Statement | | Pain | | No Pain | | No Statement | | Pain | | No Pain | | No Statement | |
| | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* |
| Davis and Kitlowski (190 cases *) | 51 | 61.5 | 5 | 6.0 | 27 | 32.5 | 13 | 28.2 | 9 | 19.6 | 24 | 52.2 | 27 | 44.3 | 5 | 8.2 | 29 | 47.5 |
| Jenkins and Delaney (62 cases **) | 16 | 76.2 | 2 | 9.5 | 3 | 14.3 | 11 | 61.1 | 1 | 5.6 | 6 | 33.3 | 11 | 47.8 | 5 | 21.8 | 7 | 30.4 |
| Weaver (38 cases) | 33 | 86.8 | 2 | 5.3 | 3 | 7.9 | | | | | | | | | | | | |
| Total | 100 | 70.4 | 9 | 6.4 | 33 | 23.2 | 24 | 37.5 | 10 | 15.6 | 30 | 46.9 | 38 | 45.2 | 10 | 11.9 | 36 | 42.9 |

* From the original series of 212 cases reported by these authors, Jenkins and Delaney deleted eighteen cases; the present author removed three; and one case was unclassified as to location and was, therefore, omitted.

** Not included in the series of Davis and Kitlowski.

Pressure on a nerve is said to be a factor. This may be true. There was demonstrable nerve pressure in only a few instances, as in Case 1, but not all of these patients had pain. In addition, as previously mentioned, many hemangiomata change from the quiescent to the painful stage with no alteration in size. The location of the tumor as regards its liability to trauma is apparently of far greater importance in the production of pain than the type of tissue affected.

The following opinion is deduced from the foregoing evidence. Hemangiomata in themselves are not painful, but at some period they become painful as the result of irritation, congestion, or inflammation of the tumor, caused by one or a combination of the following factors, mentioned in the order of their importance: internal or external trauma, as previously defined; increased internal pressure, due to growth of the tumor and resistance of the surrounding tissues; phleboliths; or absorption of toxins from a disease process. In addition, injury to surrounding tissues, due to growth of the tumor, undoubtedly causes pain in some instances.

The objective symptoms, like the subjective ones, vary somewhat with the location of the tumor and its liability to injury. These findings, as far as angiomata of muscle are concerned, have appeared in print so frequently that reiteration here is deemed unnecessary.

Angiomata of the knee-joint capsule present uniformly more severe symptoms due to joint involvement. Pain is the most constant symptom and was present in twenty of the twenty-one* cases reported. This pain was so severe as to be totally disabling in ten cases and at least partially disabling in the other 50 per cent. There is usually marked atrophy of thigh and calf muscles and in some instances shortening of the leg. Flexion contracture of the knee with limitation of motion is common. Motion is usually painful. Hydrops of the joint was of frequent occurrence. If a tumor is palpable, it is soft and compressible and usually extremely tender to pressure. Elevation of the leg may reduce the size of the tumor. There is capsular thickening. Aspiration of the tumor produces blood. The skin is normal. In some instances roentgenograms reveal the presence of phleboliths. A patient presenting the majority of these signs and symptoms is entitled to an exploratory arthrotomy.

Davis and Hertzler mention that hemangiomata at times undergo spontaneous cure. Traub states that capillary and cavernous hemangiomata have been definitely observed to disappear spontaneously in a number of cases, the latter much more rarely, however, than the former. Case 5 is considered to be an example of spontaneous obliteration of a cavernous hemangioma. This supposition is based on the following data. The patient was of the correct age, and pain first made its appearance after exercise. There was a three-year period of no symptoms, indicative of a change in the pathological process. The site is a favored one for

* An additional case, reported by Mizuno, has been noted since this series was compiled.

hemangiomata. The roentgenogram revealed a phlebolith consisting of concentric rings, which, according to Davis and Kitlowski and also to Watson-Jones and Roberts, are pathognomonic of a phlebolith occurring in a hemangioma. Many hemangiomata, in microscopic section, show areas of fatty and hyaline degeneration, which were markedly present in this instance. One small section of the specimen in this case was suggestive of the remains of a hemangioma. It is probable that the phlebolith in this instance cut off the blood supply with resultant degeneration of the tumor. Foreign-body irritation occurred some time later, as evidenced by the histological picture, and there was a recurrence of the tenderness to a blow. The obliteration of the tumor did not give permanent relief from the symptoms, and, in this instance at least, the phlebolith must have been a factor in the production of pain.

Excision is the treatment of choice and is eminently satisfactory. Some of the widely invasive angiomata present marked mechanical difficulties in their removal, and instances of severe hemorrhage have been reported. The injection of a variety of sclerosing solutions and radium and x-ray therapy have been utilized in the treatment, but these methods have not proved nearly as efficient as surgery. Some type of surgical removal was done in all of the 142 cases in this series where the type of treatment was stated. There were four amputations and one resection of the knee joint. There was recurrence of the tumor in seven instances, one as late as eight years following excision. It is suspected that recurrence is more prevalent than these statistics indicate, since many cases were followed for only a short period and a note on the result was frequently omitted. One death occurred, but this was due to "exhausting diarrhoea" and not to the hemangioma.

The author is indebted to his chief, Dr. C. B. Francisco, for permission to report some of the cases and to Dr. H. R. Wahl for the pathological reports.

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# POSTERIOR DISLOCATION OF THE ELBOW JOINT COMPLICATED BY FRACTURE OF THE MEDIAL EPICONDYLE AND ULNAR-NERVE INJURY

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*From The Guthrie Clinic*

Posterior dislocation of the elbow does not as a rule present many difficulties in the way of treatment. Occasionally, however, complications arise, which, if not recognized and properly treated, result in considerable loss of function in the affected joint. An important and not infrequent complication is fracture of the medial epicondyle. The displaced fragment may become incarcerated in the joint fissure at the time of reduction, with consequent limitation to full motion, and eventually a traumatic arthritis develops. At times the epicondylar fragment is accompanied by the ulnar nerve, and symptoms of a typical ulnar neuritis soon appear. The clinical and roentgenographic findings are quite characteristic,—namely, a block to motion, bony in character; ulnar neuritis occurring immediately or within a few days; an extra shadow in the joint space representing the detached fragment; and the absence of the medial epicondyle from its usual place in the roentgenogram. This is a syndrome which could not apparently be overlooked. Writers on the subject, however, agree that this condition is in fact frequently overlooked. In a large measure this is due to the paucity of literature on the subject. Standard textbooks, as a rule, make no mention of this

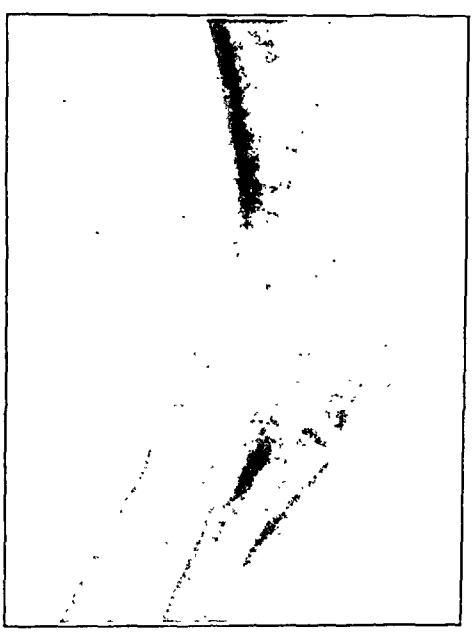


FIG. 1-A



FIG. 1-B

Case 1. Demonstrating the detached epicondyle displaced downward and lying in the joint.

condition. Only a few articles dealing with the subject have appeared in the medical periodicals during the past few years. These include papers by Speed and Macey, Cotton, and Stern.

Three cases with displacement of the detached medial epicondyle into the joint have been seen at The Guthrie Clinic. In two of these, symptoms of ulnar neuritis were present.

## CASE REPORTS

CASE 1. H. G., a male, seventeen years old, came to the Hospital after direct injury to the elbow, complaining of marked tenderness on the inner side of the elbow and some deformity. A small area of anaesthesia over the dorsal surface of the ulnar side of the hand and the little finger was found clinically, with no apparent motor disturbance. There was no interference with the circulation. A diagnosis of dislocation of the elbow, chipped fracture of the medial epicondyle, and contusion to the ulnar nerve was made. After closed reduction of the dislocation and the fracture, a plaster splint was applied. Check-up roentgenograms, taken after reduction, still showed the presence of a fragment of bone within the joint and, accordingly, the patient was strongly urged to consent to surgical intervention. He refused and has since been lost sight of. When last seen, he had had no return of sensation in that area of the hand and the forearm supplied by the ulnar nerve and was unable to extend the elbow completely.

CASE 2. H. S., a male, thirteen years old, came to the Hospital complaining of pain in the right elbow, which had been present for three days following a fall. Examination on admission revealed marked swelling about the right elbow with discoloration most marked about the medial aspect of the arm. No areas of anaesthesia were found over the forearm or the hand, but there was a definite muscle



FIG. 2-A



FIG. 2-B

Case 2. The epicondyle is seen lying within the joint before operative removal.



FIG. 3-A

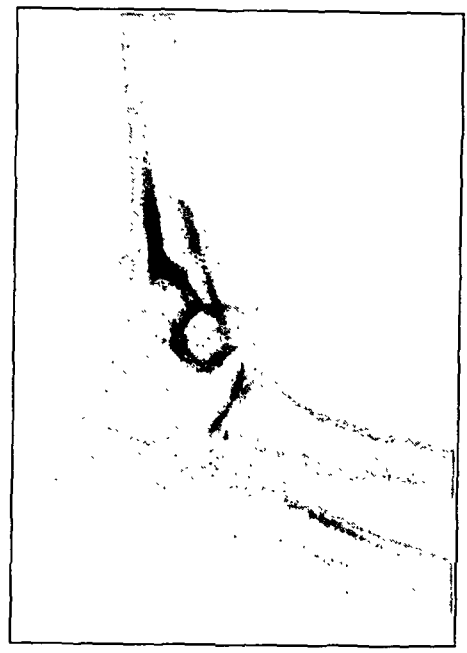


FIG. 3-B

Case 3. Before reduction. Showing the epicondyle displaced downward.

palsy in that portion of the hand supplied by the ulnar nerve. The patient was unable to extend the forearm completely, and, on any attempt to extend the part, he complained of a burning sensation shooting into the hand and the little finger.

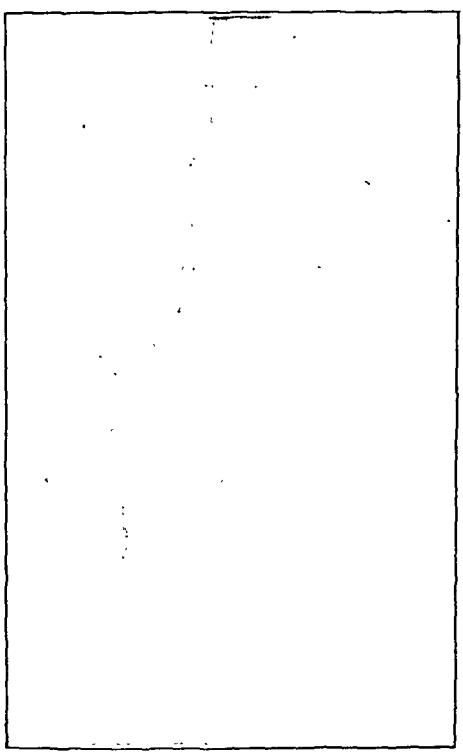


FIG. 3-C

Case 3. Anteroposterior view after closed reduction. The epicondyle is shown near its epiphyseal bed. (The lateral view after reduction does not show the epicondyle.)

A roentgenogram showed separation of the epiphysis of the medial epicondyle of the right humerus. In view of the fact that the detached epicondyle had entered the joint, as evidenced by its position in the roentgenogram and by the presence of a "locked joint", the patient was urged to have surgical intervention, to which he consented. An incision was made along the medial aspect of the elbow, and the joint cavity was entered. At first, some difficulty was encountered in locating the detached epicondyle within the joint, but, after the ulnar nerve had been identified and isolated in the lower arm and followed downward, it was found to lead to the fragment of bone that had been displaced into the joint. The epicondyle was removed completely and the ulnar nerve was transplanted anteriorly. After an uneventful convalescence, the patient was discharged, employing active motion. At the time of his discharge he had had some return of the motor function along the ulnar side of the forearm and the hand. However, when seen eight weeks after operation, there was marked flaccidity of the pollicis adductor muscle with marked wasting in the inter-

osseous spaces. The patient was unable to adduct the little finger. Sensation was almost normal.

CASE 3. W. C., a young boy, was recently admitted to the Hospital with a dislocation of the elbow and with the medial epicondyle displaced downward and forward. Reduction of the elbow dislocation was easily accomplished with right-angle traction, and the epicondyle was manipulated upward and backward to resume its normal relationship with the lower inner aspect of the humerus. No ulnar symptoms could be demonstrated either before or after reduction. In this instance, closed reduction was successful in overcoming one of the complications associated with posterior dislocation of the elbow.

## SUMMARY

1. Fracture of the medial epicondyle may be a complication of posterior dislocation of the elbow joint.

2. Occasionally, in reduction of the dislocation, the detached epicondyle may become incarcerated in the joint with consequent limitation to full motion and with the possibility of the development of a traumatic arthritis at a later period.

3. Operative removal is indicated if closed manipulation is unsuccessful in removing the detached epicondyle from the joint space.

4. Occasionally, the ulnar nerve is carried along with the epicondyle, and an immediate or delayed ulnar neuritis may develop.

5. Operative interference is indicated if an ulnar neuritis occurs.

6. If an open operation is required in the treatment of these complications of posterior dislocation of the elbow, removal of the epicondyle from the joint and transplantation of the ulnar nerve anteriorly are the objectives.

7. These particular complications should be kept in mind in cases of posterior dislocation of the elbow joint, especially in children.

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## TECHNIQUE

### *Incision*

The incision should be curved like a long-drawn-out S, so as to reduce tension when suturing, and it should run from the internal cuneiform, along the upper border of the abductor hallucis to the side of the great toe opposite the interphalangeal joint,—along the anterior two-thirds of the inner border of the foot, as one must have good exposure to reach both flexor and extensor tendons and to induce them to run a smoothly converging course at the end of the operation. No transplant works well in which the united muscles meet at a wide angle.

Skin flaps are dissected up in both directions, as much as possible in the plane immediately over the tendon sheaths, so as to avoid the large plexus of veins. Some of these must be divided and ligatured, but a tourniquet is not necessary and, since in these cases the circulation is poor, it seems to the writer that the use of a tourniquet jeopardizes the vitality of the thin skin flaps.

### *Freeing of the Tendons*

The flexor tendon is found in its sheath, lying close to the plantar aspect of the proximal phalanx. The sheath is opened, and the tendon is pulled out with a blunt hook and traced up as far as the middle of the metatarsal. The toe is then bent sharply, and the tendon is divided as near its insertion as can be reached without making a skin scar under the phalanx, which might become painful on weight-bearing. The tendon must not be freed too far up the foot, for, if it should slip onto the dorsum of the metatarsal head, it would cease to have its plantar-flexing action.

The extensor tendon is lifted out of its sheath for several inches. If it becomes like a bow-string when the claw attitude is corrected, it must be lengthened by splitting it Z-fashion for several inches. Unless the split is a long one, there will be more separation than one expects and no overlap will remain for suturing of the ends.

### *Joint Contractures*

If free plantar flexion has not been attained in the metatarsophalangeal joint, it may be necessary to divide the dorsal ligament, as no transplant can be expected to correct a deformity; its action is merely to prevent relapse. If the interphalangeal joint is subluxated, it is best to arthrodese it by removing a dorsal wedge, including both cartilages. The position is easily maintained by a single catgut stitch through the soft parts.

### *Tendon Suture*

This can be done when both joints stay easily in the corrected position. The flexor tendon should be made to take a course along the side of the metatarsophalangeal joint, reaching the extensor on the dorsum of the proximal phalanx. Sometimes in severe cases it is hard to make the

stabilizing dose. A dose beyond twenty-five milligrams given intravenously must be exceeded cautiously.

An increasing dose usually gives increasing effect up to that point where the central symptomatology becomes too unpleasant. An overlap effect is present if the drug is given frequently enough.

The excretion of the drug is rapid and limits the duration of effect which is usually one to two days, but the duration may vary from four hours to several days.

The drug is injected every day or three times weekly, as a rule. The repetition of the curare is not harmful.

The central symptomatology is manifest about fifteen to twenty minutes after intramuscular injection, or during or immediately after intravenous injection. This symptomatology is not constant in the smaller doses but increases with clinically effective dosage.

The patient becomes a little dizzy and sometimes sleepy. The eyes feel fluttery, and there seems to be a mist before them. The upper lids are heavy and sometimes partly dropped, and it becomes difficult to open the eyes. Diplopia is sometimes present. With larger doses, there is facial masking so that the face seems to bear an expression of amazement, stupefaction, or blankness.

These symptoms are not unwelcome to the patient who may accept them as a sign of activity of the drug. They last for ten to thirty minutes.

Toxic symptoms were observed in two cases in whom doses of more than thirty milligrams were given intravenously. The mouth was open and saliva drooled from it. The color of the face was ashen gray. The eyes were held half closed and the facial expression was fixed. The head hung heavy as if its weight were too great for the neck. The patient was unable to walk because of dizziness and ataxia. There was no disturbance in breathing.

These alarming symptoms pass quickly. They will only be noted after the injudicious use of too great a dose of curare.

The *muscle effect* depends on a theoretical muscle-relaxing component in curare, as opposed to the paralyzing component. It is not possible to render a limb completely flaccid within the range of therapeutic dosage. But there is an elective release of muscle spasm and rigidity which leaves normal musculature unchanged. Certain muscle groups are more sensitive to curare and it is usually difficult to overcome thenar spasm and palmar flexion of the wrist. Soft-muscle rigidities respond better than those of hard ones. The estimate of rigidity is tested empirically by palpation of the muscle. Plastic suspension of a limb is often overcome. Abnormal movements diminish. Clonic or hyperactive reflexes are lessened or the reflex is brought out when extreme muscle rigidity originally prevented its appearance. The extent of actual paralysis or paresis of muscles can be estimated after curare. By release of spasm and rigidity, a limb may show active power where none seemed

# CURARE THERAPY FOR THE RELEASE OF MUSCLE SPASM AND RIGIDITY IN SPASTIC PARALYSIS AND DYSTONIA MUSCULORUM DEFORMANS

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*From the Hospital for Joint Diseases* *

The use of curare in spastic paralysis and in certain of the dystonic diseases such as dystonia musculorum deformans, spasmodic torticollis, and the dystonic syndromes is based upon the fact that curare has the specific effect of interrupting the transmission of the nerve impulse to muscle. This action, which takes place at the myoneural junction, is such that it strikes at hyperinnervated muscles before it affects normal musculature. This is true experimentally and clinically. The action of the drug is a peripheral one. No distinction in treatment need be made then between lesions of the pyramidal tract and those of the extrapyramidal tract. The response to curare, however, is better in lesions of the extrapyramidal tract.

The use of curare in experimental medicine is well known. The attempt to use curare clinically dates back to 1857 when its specific effect was discovered by Claude Bernard. Each clinical test repeatedly emphasized the fact that each sample of curare was variable in strength and each test indicated the necessity for standardization of the curare mixture.

The curare which the author used was made up by the Merck Institute of Therapeutic Research. Each sample of curare was accurately assayed so that four and four-tenths milligrams was a lethal dose for one-half of the white mice into which it was injected. The curare was put up as a light brown, sterile, aqueous solution in ampules containing ten cubic centimeters, each cubic centimeter of curare being the equivalent of five milligrams. This solution was not self-sterilizing.

*This curare was so accurately assayed that one sample acted as another and in quantitative exactness.*

Curare is given either intramuscularly or intravenously. It was given intravenously when the quantity of fluid to be administered was too great for intramuscular injection. Dosage is estimated by weight of the patient and by extent of muscle spasm and muscle rigidity. It varies, then, for each patient. It is most in the dystonic patient, whose average dose has been twenty-five milligrams, given intravenously. The average spastic patient, intelligent enough to cooperate, needs about fifteen to forty milligrams given intramuscularly, or ten to fifteen milligrams if given intravenously. Each patient's dose must be estimated separately. It is best to begin with an ineffective dose and work up to the effective or

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# ARACHNODACTYLIA

## A Report of Eight Cases

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Arachnodactylia, an entity considered to be comparatively rare, occurs more frequently than is generally believed. Most of the cases that have been described appear in the literature on ophthalmology. Yet the patient with arachnodactylia should certainly be of as much interest to the orthopaedic surgeon as to the ophthalmologist. However, the orthopaedic literature contains very little information on this condition. In fact, most of the leading orthopaedic textbooks give but a few lines on the subject, and leave the reader with the impression that the syndrome is very unusual. Marfan first described the condition in 1896. The foreign literature contains about ninety reported cases of arachnodactylia, while the English literature contains less than twenty-five cases, very few of which have been reported from the United States. Because so few have been mentioned in the literature of this country in proportion to the ones in foreign countries, and because, in the last seven years, eight cases of arachnodactylia have been observed in this Clinic, one is led to believe that the condition is much more common than is generally recognized.

The most important characteristics of arachnodactylia are the long, slender extremities which are most noticeable in the more distal portions of the limbs, the marked relaxation of nearly all of the joints, a general lack of normal muscle tone, and the presence of very little subcutaneous fat. The hands and feet are especially long and narrow. The phalanges are of abnormal length; hence the name "spider digits". Almost invariably, besides these symptoms, there are other congenital deformities. These abnormalities vary in number and in degree of severity. Certain defects are found in a high percentage of the cases. The head is usually of the dolichocephalic type. Eye complications—the most common of which are ectopia lentis and iridodonesis—are present in about 40 to 50 per cent. of the cases. If the lens is not dislocated, lenticular myopia is frequently present. Other eye complications, such as chorioretinitis, have been observed. The ears are usually large. The upper half of the auricle protrudes, but the lower half is in close apposition. The auricular cartilage is usually underdeveloped. In most cases, the mouth shows a characteristically high palate. Abnormalities often occur in the teeth, one of the more common of which is a marked "overbite". The teeth may be long and narrow, and double rows of teeth have been reported. The chest frequently shows deformity, such as pigeon breast. Winged scapulae are very often noted. The spine, in many of the cases, shows

* Service of Fremont A. Chandler, M.D.

to exist before. The author has been particularly interested in the hand and has taken the movement of picking up a glass of water and drinking from it as a large gross movement in testing for useful muscle power after curare.

Curare can not alter fixed contracture or deformity.

Pulse and blood pressure are not affected with the usual therapeutic dose. No constant pupillary change or nystagmus has been noted. No curare glycosuria was noted when test was made for urinary sugar.

The effect of curare is most striking in dystonia musculorum deformans. The effect may be dramatic. A bedridden patient becomes able to stand and even to walk, as in a walker. Dystonics with extreme rigidity may be benefited only a little, but it is worth while to try the drug in each case. The drug is useful, too, in fractional dystonic syndromes, as spasmodic torticollis.

## SUMMARY

Properly assayed curare is safe in therapeutic dosage. This drug has a definite place in the release of muscle spasm and rigidity in spastic paralysis and dystonia musculorum deformans.

forty-two males. Race apparently is of little significance. The disease is definitely familial. There has been considerable controversy concerning the exact etiology of arachnodactylia. The most widely accepted theory today is that it is due to a disturbance of mesoblastic growth. With the exception of the eyes, only mesoblastic tissues are involved. Most probably, the lens, which is of ectodermal origin, is secondarily affected by the weakening of the supporting tissues which most authors believe to be of mesodermal origin. The diagnosis is made on the finding of extremely long, slender, relaxed extremities accompanied by other congenital deformities, particularly those involving the eyes. There are certain other diseases that must be considered before arriving at the final diagnosis. The Charcot-Marie-Tooth type of atrophy is a progressive disease and should not offer any great difficulty in the differential diagnosis. Status dysgraphicus or microform syringomyelia presents a picture similar to arachnodactylia, with the exception of the eye findings. In the former there are usually present heterochromia of the iris, Horner's syndrome, and occasionally cataract; in contrast to the dislocation of the lens and the poor reaction of the iris to mydriatics in the latter.

From the orthopaedic surgeon's standpoint, the treatment of arachnodactylia is concerned with the correction of the existing deformities. Of the eight patients whose cases are presented in this paper, the first two are a brother and sister. The next four patients are from one family, while the last two are not related.

## CASE REPORTS

CASE 1. F. S. (No. 47637), a poorly nourished white boy, thirteen years of age, entered the Hospital because of curvature of the spine. His past history and family history were negative, except for the usual childhood diseases.

The patient was a thin, poorly nourished individual. His head was dolichocephalic in type. Examination of the eyes revealed blue sclera and anomalous discs with deep cups. There was an incomplete central scotoma for colors in both eyes. The ears were large with a decreased amount of auricular cartilage. Examination of the mouth showed a highly arched palate and very irregular and carious teeth. The chest was of the pigeon-breast type. The heart was enlarged to the left with a thrill at the apex. A diastolic murmur was present just inside the nipple line. Examination of the back revealed scaphoid scapulae, and a marked right high dorsal, left thoracolumbar kyphoscoliosis. The fingers were very long and tapering, and there was considerable wasting of the palmar muscles. The feet were long and narrow. Marked generalized muscle atrophy and definite acrocyanosis were noted. Laboratory findings were negative. The patient died of heart disease at the age of twenty.



FIG. 2

Case 2. L. S. Narrow hands with tapering fingers.

marked deformity of various types, such as extreme kyphosis and lordosis, and, most commonly, kyphoscoliosis. Spina bifida is not an uncommon finding. The heart is affected in about 45 per cent. of the patients, various congenital defects such as patent foramen ovale and incompetent valves being the most common forms of disorder. Various abnormalities of the blood vessels have been observed. Abnormal division of the lobes of the lungs has been seen at autopsy. In addition to the abnormal length of the extremities, webbing of the fingers and toes and various forms of contractures have been described. However, it is more common to see disturbances due to marked relaxation of the joints, such as extremely relaxed flat feet. Acrocyanosis is frequently present. Roentgenographic examination shows rarefaction of the bones and advancement of ossification. Mentality is usually normal.

Arachnodactylia occurs about equally in the two sexes. Weve, in tabulating eighty-two reported cases, found it in forty females and in



FIG. 1-A

Case 1. F. S. Pigeon breast, long slender extremities.



FIG. 1-B

Severe kyphoscoliosis.

tion of the head revealed a long skull with normal tables, sella turcica, and sutures. The spine showed right thoracic, left lumbar scoliosis. Roentgenographic examination of the hands showed unusually long metacarpals and phalanges. There was a mild degree of decalcification of the bones in general.

On November 5, 1935, bilateral navicular-cuneiform arthrodeses were performed to correct the flat feet. The result was very satisfactory.

CASE 4. K. D. (No. 40695), a fairly well-nourished white boy, four years of age, a brother of the patient in Case 3, was first seen in the Orthopaedic Clinic on December 7, 1933, because of knock-knee deformity and pronated feet.

The head was of the mild dolichocephalic type. There was bilateral iridodonesis of the eyes with subluxation of the lens. The palate was found to be highly arched. The teeth were normal except for several which were carious. The chest was of the pigeon-breast type. Examination of the heart revealed a systolic murmur over the second interspace on the right when the patient was standing and on the left when he was recumbent. There was a right thoracic, left lumbar curvature with an increase in the thoracic rounding and lumbar lordosis. The hands and feet were long and slender. Moderate genu valgum and marked pronation of both feet were noted. Roentgenographic examination showed that the skull was long, but otherwise normal. The sella turcica was normal. The spine had a right thoracic and left lumbar curvature.



FIG. 4

Case 4. K. D. Pigeon breast, abnormally long extremities, genu valgum, and pronated feet.

CASE 5. G. D. (No. 42978), a tall, poorly nourished, white male, eight years of age, a brother of the patients in Cases 3 and 4, was first seen in the Orthopaedic Clinic on October 28, 1935, because of kyphoscoliosis and flat feet.

The head was of the square type with prominent parietal bosses. There was bilateral subluxation of the lens of the eyes. The palate was normal. The teeth were irregular in shape and size, and there was marked overbite. The chest was of the pigeon-breast type with a definite Harrison's groove. Examination of the back showed marked thoracic rounding with a moderate right thoracic, left lumbar scoliosis. The fingers were moderately long. The feet were long and narrow and markedly pronated. The muscles were flabby. The skin was cold and clammy. Roentgenographic examination of the gastro-intestinal tract revealed an incomplete rotation of the colon, the sigmoid and descending colon being on the right side. The skull was long, and the sella turcica was normal. The spine had a moderate right thoracic, left lumbar curvature.

CASE 6. H. D., father of the patients in Cases 3, 4, and 5, showed the main characteristics of arachnodactylia, although a complete study of his case was not made. He died of heart disease in April 1937. He was a tall, poorly nourished individual, measuring six feet six inches in height. The head was of the dolichocephalic type. The chest showed a marked deformity in the protrusion of the lower end of the sternum. A loud diastolic murmur was heard over the entire precordia. The blood pressure was 130/55. The extremities, particularly the hands and the feet, were abnormally long and thin.

This man's wife was apparently normal in every respect. They had four children,—three of them are here reported and the fourth was normal.

CASE 2. L. S. (No. 47638), an undernourished girl of nine years, a sister of the patient in the preceding case, entered the Hospital on December 30, 1930, for observation. Her chief complaint was curvature of the spine, which had existed since birth. The birth history was normal. Long fingers had been noted at birth. The patient had never been ill.

The head was of the dolichocephalic type with a prominent forehead. There was slight bilateral ptosis of the eyes. The eyeballs were rather prominent. Blue sclera and anomalous discs with deep physiological cups were noted. The visual fields were normal. The ears were large and flabby. Examination of the mouth revealed a highly arched palate and irregular teeth. The chest was of the pigeon-breast type. The heart showed normal limits, and a loud systolic murmur was heard at the apex. Examination of the back revealed scaphoid scapulae and right thoracic, left thoracolumbar kyphoscoliosis. The extremities showed marked relaxation of all joints. The hands and feet were long and narrow. The feet were markedly pronated, and the longitudinal arches were low. There was marked atrophy of the palmar and plantar musculature, with a peculiar reddish color of the palms. Roentgenographic examination showed elongation of the long bones of the hands and feet, particularly of the phalanges.

This patient is still alive and is in fairly good general health.

CASE 3. J. D. (No. 57775), a tall, undernourished, twelve-year-old white girl, was first seen at the Orthopaedic Clinic on September 12, 1935. Her chief complaint was flat feet; her past history was negative.

Examination of the mouth disclosed a highly arched palate. The teeth showed a marked overbite. The chest was of the pigeon-breast type. The left border of the heart was one-half an inch to the left of the nipple. A systolic murmur was heard from the second interspace to the fifth interspace. Examination of the back showed a moderate right thoracic, left lumbar scoliosis. Both the upper and the lower extremities were long and narrow. The elbows and knees could be readily hyperextended. All the joints showed definite relaxation. The fingers and toes were longer than in normal individuals. There was a mild degree of genu valgum. The feet were markedly pronated, and the longitudinal arches were low. Roentgenographic examina-

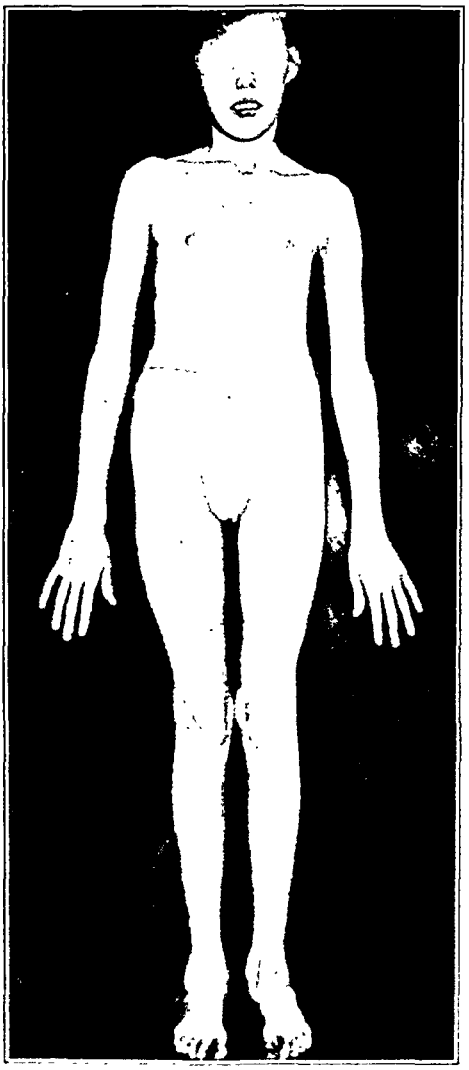


FIG. 3-A

Case 3. J. D. Pigeon breast, long slender extremities, tapering fingers.



FIG. 3-B

Irregularity of teeth with malocclusion.

tendon reach so far. It can be threaded through a slit in the extensor tendon, or, if the latter has been split and is very thin, as it commonly is in spite of its great activity, then the flexor tendon can be buttonholed and the distal end of the extensor tendon passed through it, the proximal end being sutured to the side of the junction. No. 120 linen thread makes the most convenient and least irritating form of suture. The skin is so thin over the line of union that any absorbable material like catgut is liable to irritate the skin and to work its way out. The linen becomes buried in scar tissue and is found with difficulty at any later exploration. No attempt should be made to suture the tendon sheaths, which are usually adherent and inelastic in these cases; a new sheath speedily forms and assists instead of hindering movement.

*Skin Suture*

Suture of the skin should be by interrupted stitches of silkworm gut, so as to allow free oozing, for, if a hematoma should form under tension, the skin would slough and jeopardize the vitality of the tendons beneath. After correction of the deformity, the skin is surprisingly tense in such cases, especially over the metatarsal head. In some cases a blister has occurred in this region, but exposure to the air under a wire cage for a few days (Böhler's technique) has dried it up without loss of skin or undue adherence. The skin stitches should be left in for from twelve to fourteen days.

*Splinting*

A firm bandage over plenty of wool is sufficient to fix the great toe in neutral position, but, in order to discourage movements of the tendons for ten days, a splint to hold the ankle at a right angle is useful.

*After-Treatment*

In order to give opportunity for the most favorable circulation, the patient should be kept in bed for three weeks with the limb raised on a cage. After this he can walk in a boot which is sufficiently long and wide to give room for the corrected great toe. Massage, to free light adhesions without bursting open the wound, is useful, but an intelligent patient can soon restore good movement by exercises in hot water.

## RESULTS

It is not claimed for this operation, any more than for any transplantation operation, that it will restore normal function, but in the writer's hands in every case it has relieved the pain and disability associated with corns and arthritis. There have been no relapses and improvement has been steady. The earliest case was operated upon about five years ago. All of the patients are working, and, before the operation, most of them seemed likely to have to give up work as the result of the deformity. Although the passive range of the great-toe joints may be normal after oper-



FIG. 5-A

Case 6. H. D. Protrusion of lower end of sternum.




FIG. 5-B

*A* and *C:* Patient's hands. *B:* Normal hand for comparison. Unusually long and narrow feet.

CASE 7. D. W. (No. 38022), an underdeveloped white girl, was first seen at the Clinic on July 1, 1929, at the age of two and one-half years, because of a limp on the left side. The limp had been noticed when she first began to walk at eighteen months. The birth history was normal, and she had had no sickness.

Examination showed a fairly well-nourished white girl with a gait typical of congenital dislocation of the left hip. The head was irregular in shape with large parietal bosses. Examination of the eyes showed congenital dislocation of each lens. The palate was highly arched, and the teeth were irregular. Examination of the chest showed

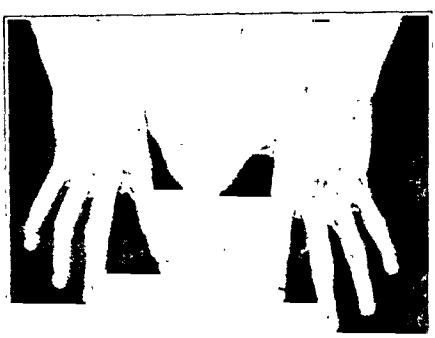


FIG. 6-A

Case 7. D. W. Characteristic hands, showing tapering fingers.



FIG. 6-B

Extremely pronated flat feet.

flaring of the lower ribs. The border of the heart was enlarged to the left. There was a systolic murmur over the pulmonic area. The spine was straight at the first admission. Examination of the extremities revealed congenital dislocation of the left hip. The hands and feet were long and slender. The arches were low, and there was generalized relaxation at all joints.

The dislocation of the left hip was reduced by closed manipulation on July 3, 1929. A good result was obtained. In 1934, a right thoracic, left lumbar scoliosis developed. On May 11, 1937, bilateral navicular-cuneiform arthrodeses were performed in an effort to correct the flat feet. A very satisfactory result was obtained.



FIG. 6-C

Abnormally long extremities, pronated feet, congenital dislocation of left hip.

CASE 8. F. K. (No. 15583), a white girl, ten years of age, was seen for the first time in the Clinic in October 1934, because of a deformity of the cervical spine which had existed since birth. This patient was a twin; her brother was living and well. The father and mother were also living and well. The patient had had an appendectomy in July 1934.

The head was of the dolichocephalic type. Examination of the eyes showed a left convergent strabismus and left corneal leukoma. The head was held deviated to the right. The chest was of the pigeon-breast type. There was a systolic murmur at the apex of the heart. The back exhibited moderate thoracic rounding with deviation of the upper thoracic spine to the right. The extremities showed an increase in length of the hands and the feet and general muscle relaxation. Roentgenographic examination revealed a definite hemivertebra on the left side at the cervicothoracic area, with congenital fusion of the upper cervical vertebrae. Also, there was a synostosis between the first and second ribs on the left.

From a review of the literature and from a study of these eight cases, we feel that arachnodactylia is a much more common entity than it has generally been considered in the past. As may be seen in these cases, the number and severity of the accompanying deformities are variable. There may be gradations anywhere from the very mild to the very severe forms of arachnodactylia. The recognition of the multiple congenital deformities should be of particular interest to the orthopaedic surgeon.

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# CHANGES SIMULATING LEGG-PERTHES DISEASE (OSTEOCHONDRITIS DEFORMANS JUVENILIS) DUE TO JUVENILE MYXOEDEMA

## Report of a Case

BY FULLER ALBRIGHT, M.D., BOSTON, MASSACHUSETTS

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It seems worth while to report the following case history, because the facts which it brings out have been largely overlooked.

### CASE REPORT

The patient, male, aged thirteen, was first seen on October 10, 1935, because of retarded growth and a limp. He had been well and large for his age until he had had an attack of pneumonia at the age of three. Since that time he had seemed less well. Growth had been retarded, and he had done poorly at school; more recently a limp had been noted. From the age of six he had been taking very small doses of thyroid (one-tenth of a grain, Burroughs Wellcome, six times daily).

On physical examination he had the outward appearance of hypothyroidism (Fig. 2,*A*), but was mentally alert. His skin was dry and his hair was coarse and dry. There was a very slight limp. His height was 129.2 centimeters. These findings suggested juvenile myxoedema as a cause of his failure to grow. Cretinism could be ruled out by his good mentality and by the fact that he had been normal until the age of three.

A roentgenogram of the hands (Fig. 1,*A*) showed marked retardation of bone age, which strongly supported the diagnosis. Roentgenographic examination of his hips (Fig. 3,*A*) showed what was interpreted as bilateral Legg-Perthes disease.

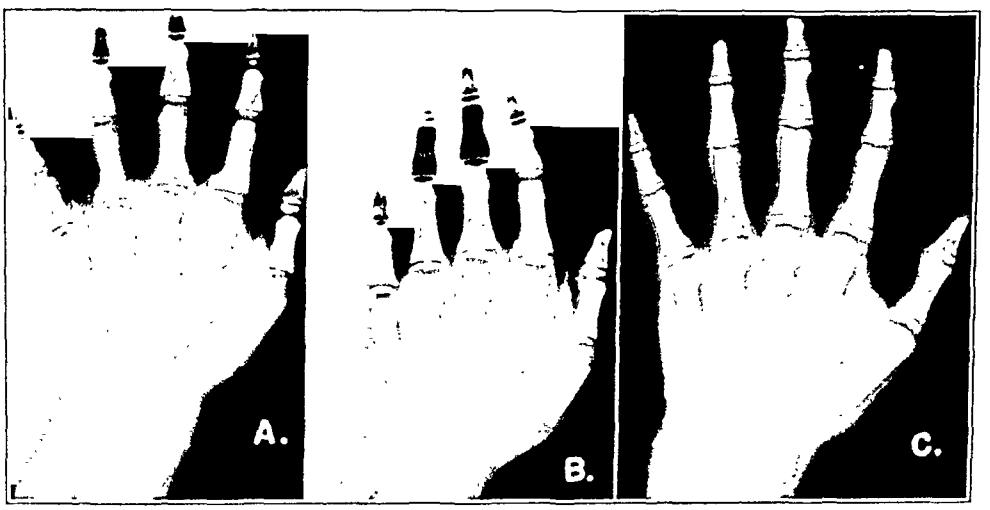



Fig. 1

*A*: Left hand on January 13, 1936, at the age of thirteen. Note marked retardation of bone age.

*B*. Left hand on June 25, 1936. Note the effect of thyroid treatment on bone age.

*C*: Left hand on December 4, 1937.

FIG. 2

*A*: Patient on October 10, 1935, at the age of thirteen, before adequate thyroid treatment.
*B*: Patient on June 25, 1936, seven months after the institution of thyroid treatment.
*C*: Patient on November 13, 1937, two years after thyroid treatment was begun.

A basal metabolic-rate determination was minus 16 (weight standard).

Although the accepted orthopaedic treatment for the hip condition is to stop all weight-bearing, this seemed rather drastic and, in view of the fact that the patient had one disease which could be treated, it seemed justifiable to see whether the hip condition (the connection between this and the hypothyroidism was not then appreciated) might not likewise respond to thyroid medication. Accordingly, he was given one grain of

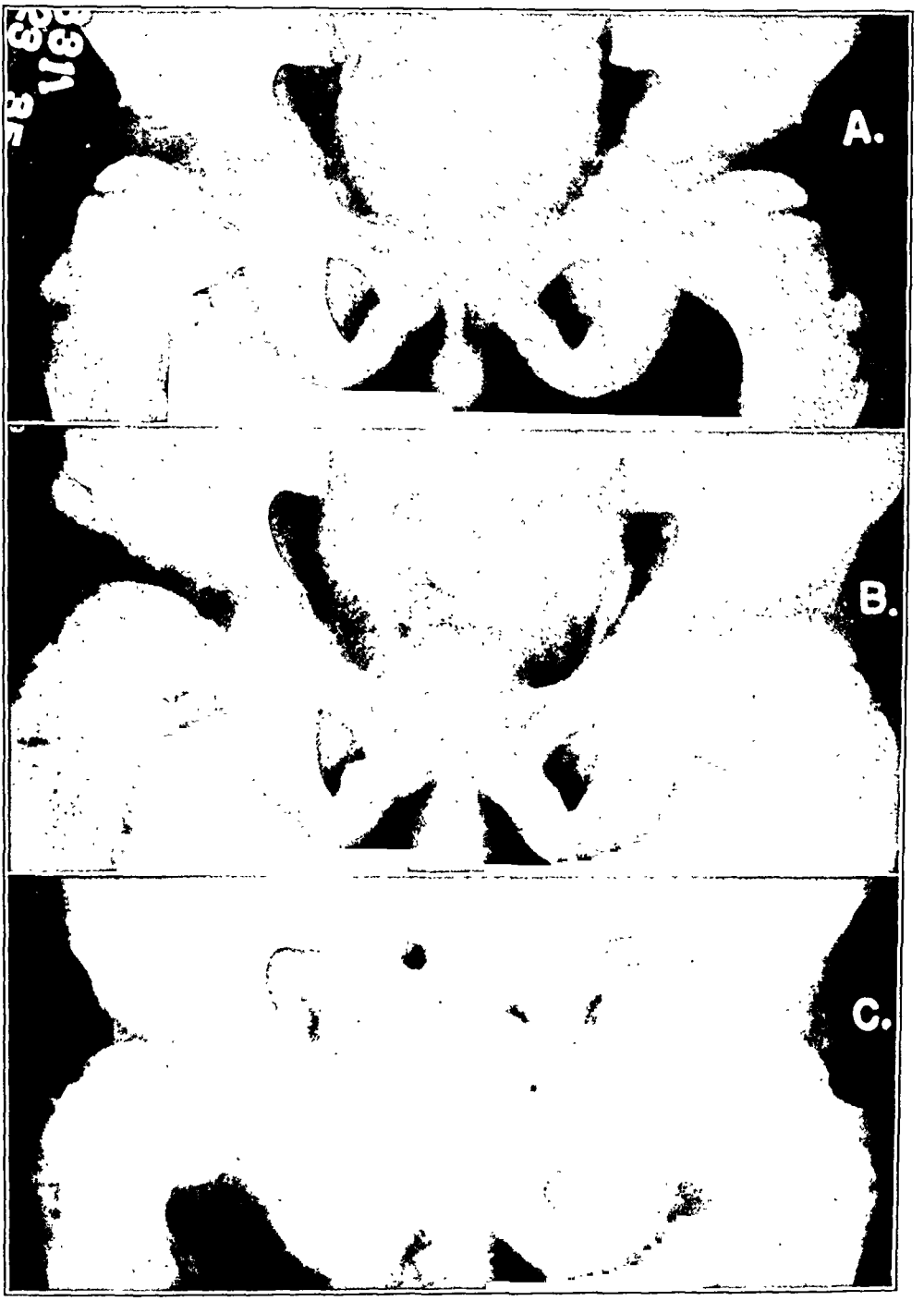



FIG. 3

*A*: November 23, 1935, at the age of thirteen.
*B*: June 25, 1936.
*C*: November 13, 1937.

Armour's thyroid daily; in a few weeks the dosage was increased to one and one-half grains daily. Since one grain of Armour's thyroid is equivalent to one grain of U.S.P. thyroid, whereas one grain of Burroughs Wellcome thyroid equals only two-fifths of a grain of U.S.P. thyroid, it will be seen that the dosage was much increased.

The patient immediately improved in all respects. The limp disappeared, and he gained eight centimeters in height in the next seven months. (See Figure 2,*B*.) The bone age increased in a most astonishing manner (Fig. 1,*B*). The femoral epiphyses showed marked improvement (Fig. 3,*B*).

When last seen, at the end of two years of treatment (Fig. 2,*C*), the bone age was no longer retarded (Fig. 1,*C*), the heads of the femora had entirely filled in (Fig. 3,*C*), and the patient had gained twenty-five centimeters in height during the two-year period.

## DISCUSSION

This case shows that a condition which has the roentgenographic appearance of Legg-Perthes disease may occur in hypothyroidism and can be cured by thyroid medication. Similar observations to the ones here reported were made by Cavanaugh and Shelton, who found in five cases of what they considered Legg-Perthes disease a family history of colloid goiter, retardation of bone age, and striking improvement following thyroid medication. The questions of course arise as to how constant such epiphyseal changes are in hypothyroidism and whether all cases of Legg-Perthes disease are on a hypothyroid basis.

That epiphyseal changes occur in cretinism has been well recognized in the German literature since the monograph by Bircher in 1909 on the

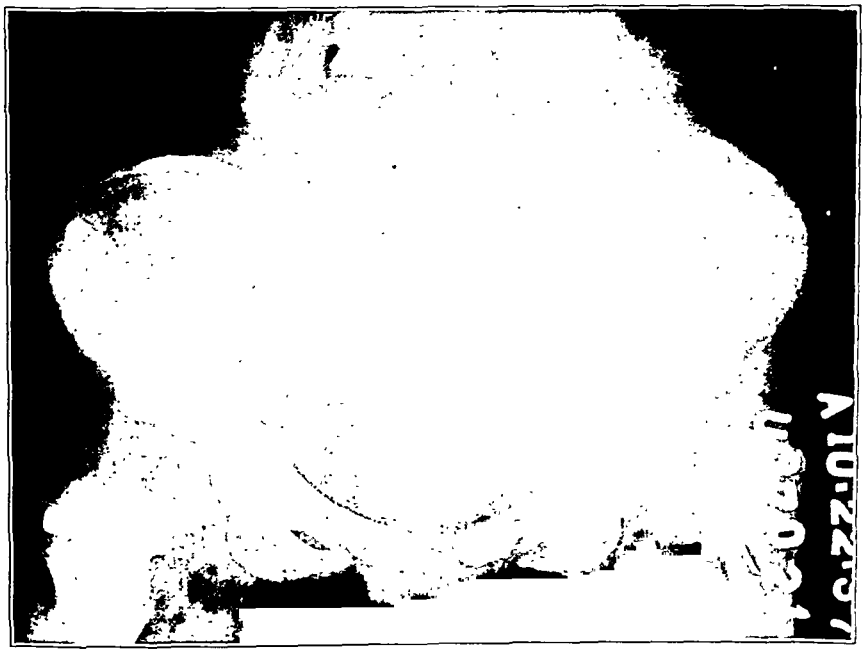


FIG. 4

Roentgenogram of the hips of an untreated case of cretinism (patient aged twenty-four).

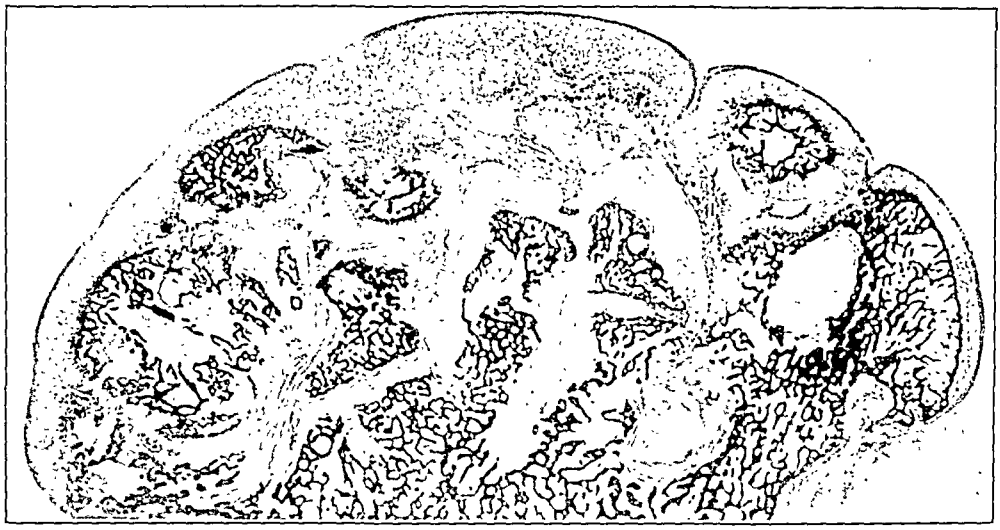


FIG. 5

Section through the head of the femur of a cretin, showing bone pathology to be a delay in transformation of cartilage into bone. Reproduced from Looser, p. 355. (*Courtesy of Gustav Fischer.*)



FIG. 6

Drawing of trabeculae composed almost entirely of cartilage with only a surface covering of bone. Reproduced from Looser, p. 353. (*Courtesy of Gustav Fischer.*)

skeletal changes in cretins. In fifteen of twenty-six cases of cretinism, Looser found changes in the femoral epiphyses similar in regard to their

roentgenographic appearance to those seen in Legg-Perthes disease. Wilkins, at the Johns Hopkins Hospital, who has made a study of cretinism, has seen multiple instances of the condition. The author has seen recently at the Massachusetts General Hospital on the Service of Dr. Harold L. Higgins, a cretin (L. B., M. G. H. No. 87021), aged twenty-four, who has received almost no thyroid medication during her life, and in whom epiphyseal changes are present. (See Figure 4.)

The pathology of the epiphyseal changes in hypothyroidism was beautifully demonstrated by Looser, who found it to be a retardation in the transformation of cartilage into bone in the epiphyses. (See Figures 5 and 6.) Since the pathology in Legg-Perthes disease is aseptic subchondral necrosis of the epiphysis (Zemansky), Looser was probably right in emphasizing that the epiphyseal lesion in hypothyroidism is not Legg-Perthes disease, although often mistaken for it clinically. This explanation of the pathology is most logical in view of the accompanying retardation of bone age seen in cretinism and in juvenile myxoedema.

## SUMMARY

1. In the case of juvenile myxoedema reported, roentgenographic examination showed changes indistinguishable from Legg-Perthes disease. These changes promptly cleared up on thyroid medication.

2. From the literature, it is clear that lesions occur in the epiphyses of cretins, which are similar roentgenographically to those seen in Legg-Perthes disease. From the work of Looser, however, it appears that the pathology in the epiphyses in the two conditions is entirely different.

3. Hypothyroidism and, as suggested by Shelton and Cavanaugh, retarded bone age should be looked for in all cases of apparent Legg-Perthes disease.

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# TRAUMATIC DISLOCATION OF THE HIP FOLLOWED BY PERTHES' DISEASE

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The association of traumatic dislocation of the hip with Perthes' disease was first drawn to the author's attention by the case to be reported. The recognition of this association is of value because of the light which it may throw upon the etiology of Perthes' disease. The factor of trauma in the etiology of this lesion is still a moot question. The case to be described is presented as an additional observation, which tends to confirm a traumatic etiology of Perthes' disease. Cases in which Perthes' disease has supervened upon traumatic dislocation of the hip have been published previously. A review of the literature discloses the following case reports.

Sundt, in 1920, reported two such cases of traumatic luxation in two boys, nine years of age, occurring nine months and three years, respectively, before the appearance of Perthes' disease. In 1919, Elmslie described a typical case of Perthes' disease which developed in the hip of a boy, four years of age, one year after he had had a traumatic dislocation. Rehbein, in 1922, reported a case of an eight-year-old boy, in whom a traumatic dislocation of the hip was followed one year later by Perthes' disease. Nicolaysen, in 1931, described a case of a boy, ten years of age, who had a traumatic dislocation of the hip, followed in one year by Perthes' disease.

To this group of five cases the author wishes to add the following case.

## CASE REPORT

M. B., male, aged ten and one-half years, was admitted to the Barnert Memorial Hospital on November 1, 1934, immediately after an automobile accident. Roentgenographic examination (Fig. 1) on admission showed a subluxation of the right hip. There was no evidence of Perthes' disease, even when the roentgenograms were studied in retrospect. Under general anaesthesia, reduction was attempted and a plaster-of-Paris spica was applied. Postoperative roentgenograms (Fig. 2), taken on November 8, 1934, showed a complete dislocation of the right hip. On the same day the dislocation was reduced, and the right hip was immobilized in a plaster-of-Paris spica. Roentgenographic examination (Fig. 3) confirmed the reduction. The patient was discharged from the hospital on November 13, 1934. Three weeks later, the spica was removed and physiotherapy was instituted. Two and one-half months later, the patient walked without a limp and without pain.

The patient was perfectly well until December 1935 (thirteen months after the time of the accident), when he began to limp and to complain of slight discomfort in the region of the right hip and thigh with radiation of pain to the right knee. He was treated by means of salicylates, physiotherapy, and occasional rest in bed. In spite of all treatment, the pain and limp continued and gradually increased in severity.

* Service of Samuel Kleinberg, M.D. † Service of William Spickers, M.D.

The author was first consulted on February 22, 1937, and examination revealed a flexion-adduction deformity of the right hip, together with limited abduction and internal rotation. In addition, there was atrophy of the right thigh and calf, prominence of the right greater trochanter, and one-quarter of an inch of shortening of the right lower extremity. Roentgenographic examination (Fig. 4), on February 22, 1937, showed typical flattening of the right femoral head with irregular areas of condensation and rarefaction. The adjacent part of the neck was broadened and was irregular in density. The patient was fitted with a Thomas traction caliper brace and remained ambulatory.

Roentgenographic examination (Fig. 5), on August 23, 1937, showed the surface of the epiphysis approaching a more normal curve and its density returning to normal. Clinically, the patient had a complete range of painless motion and was otherwise symptom-free.

## DISCUSSION

The assumption that there might have been a previous incipient Perthes' disease, the development of which was hastened by trauma, has little in its favor. A careful study of the early roentgenograms fails to disclose any evidence of epiphyseal disturbance or separation.

In a series of ninety-eight cases of Perthes' disease, forty-one of which were reported by Eyre-Brook and the remaining fifty-seven by Sutro and Pomeranz, 75 per cent. occurred between the ages of four and

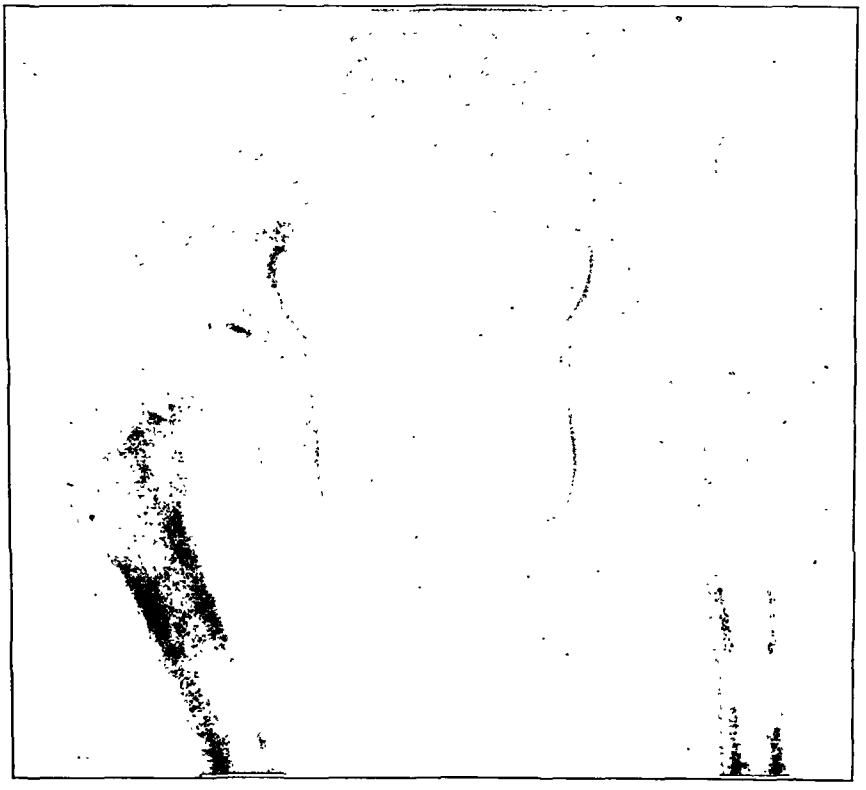


FIG. 1

Roentgenogram, taken on admission on November 1, 1934, showing subluxation of the right hip.

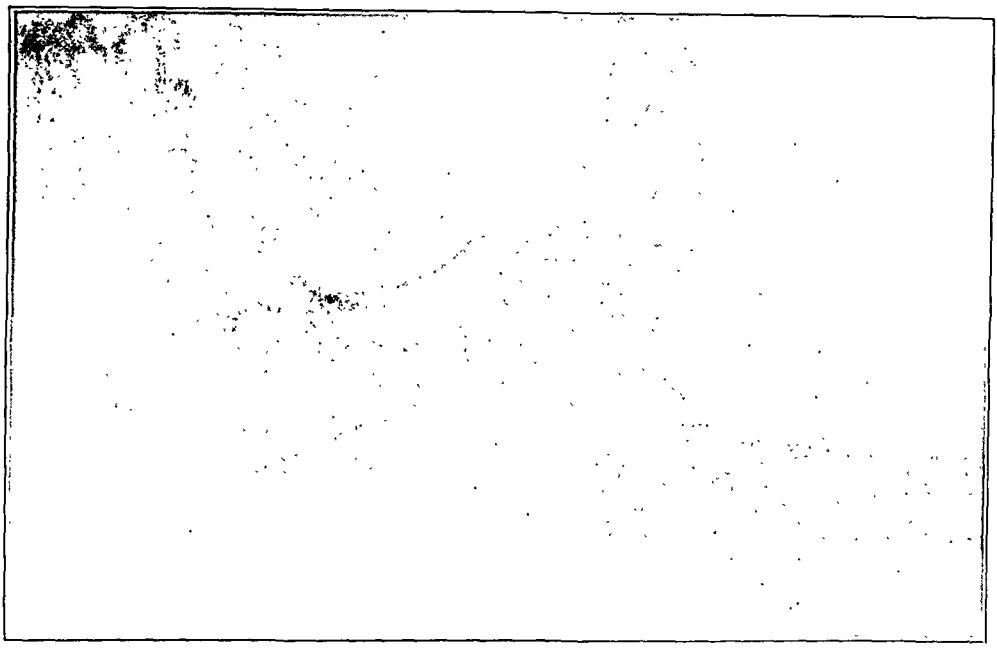


FIG. 3

Roentgenogram after reduction and immobilization of the right hip in a plaster-of-Paris spica.

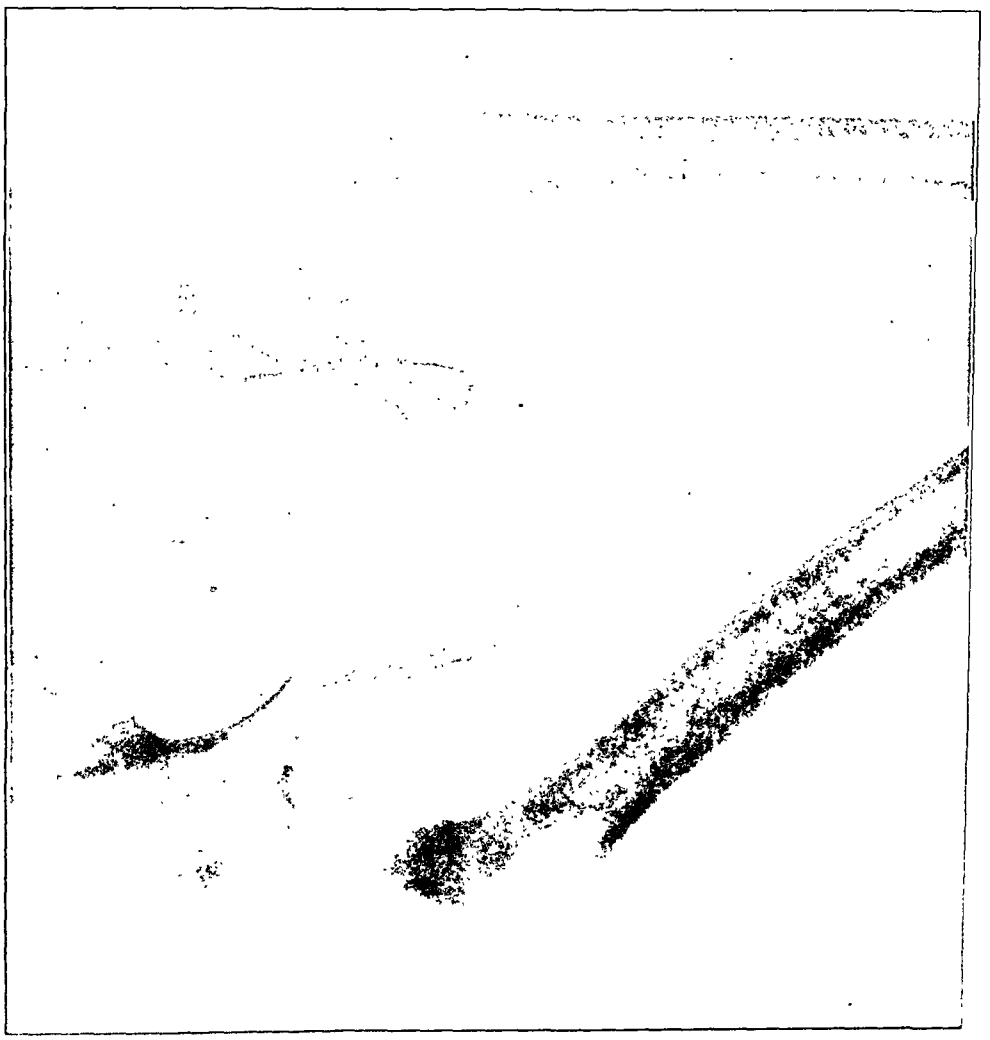


FIG. 2

Postoperative roentgenogram, November 8, 1934, showing a complete dislocation of the right hip.



FIG. 4

Roentgenogram, February 22, 1937, showing typical flattening of the right femoral head with irregular areas of condensation and rarefaction.

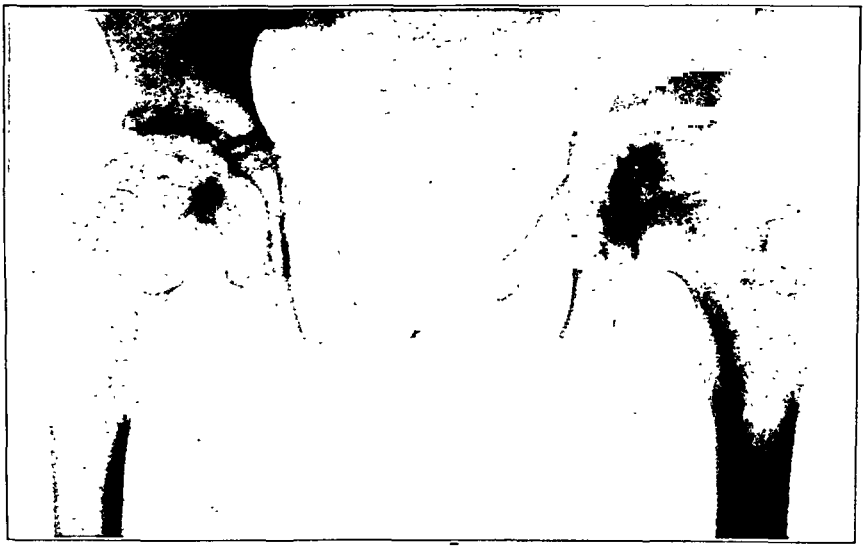


FIG. 5

Roentgenogram, August 23, 1937, showing the surface of the epiphysis approaching a more normal curve and the density returning to normal.

nine years. In the cases reported by Nicolaysen and the author, the patients were ten and ten and one-half years of age, respectively, when the dislocation occurred; this is somewhat later than Perthes' disease ordinarily occurs. The number of instances in which clinical and roent-

ation, provided that severe arthritis has not involved them before operation, yet the active range will be only about 20 degrees in each direction from neutral, the two phalanges moving as one rod about the metatarsal head. This is the amount required for walking and standing.

## COMPLICATIONS

In a certain number of cases there is a similar claw attitude of all the toes. If the toes are not fixed and the corns are not painful, the deformity can be ignored. If the sole muscles seem fairly good and the extensor tendons alone are shortened, tenotomy may restore balance.

In more severe cases, it would be too tedious to do a similar transplantion operation on each toe, whereas excellent balance can be obtained by Hohmann's operation of looping the extensor digitorum longus tendons around the neck of the third or fourth metatarsal. A separate incision must be made for this,—a J-shaped incision along the fifth metatarsal is best. The tendons are cut at the root of the toes; the periosteum is raised around the neck of the metatarsal with an aneurysm needle; and, after the tendons have been secured with guide threads, these threads are used to pull the tendons in pairs around the bone from opposite sides. Two stitches then suffice to anchor the ends together, while the ankle is kept at a right angle. The extensor digitorum brevis tendons should be left intact to prevent dropping of the toes themselves. This is a simple operation of astonishing efficacy.

## CONCLUSIONS

Clawing of the great toe is a disabling complication of some cases of poliomyelitis and other forms of paralysis. It can be satisfactorily corrected and relapse can be prevented by transplantation of half or all of the flexor digitorum longus tendon into the extensor hallucis longus tendon. If the other four toes are also deformed, they are best treated by looping their extensor tendons around the neck of one of the metatarsals.

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# BILATERAL CONGENITAL TALONAVICULAR FUSION

## Report of a Case

BY PAUL W. LAPIDUS, M.D., F.A.C.S., NEW YORK, N. Y.

*Adjunct Orthopaedic Surgeon, Hospital for Joint Diseases,* New York;*
*Associate Orthopaedic Surgeon, Trinity Hospital,† Brooklyn*

Congenital fusion of the tarsal bones was discussed by the author in the October 1932 issue of *The Journal of Bone and Joint Surgery.* A case of congenital talonavicular fusion was likewise reported. This case was considered the third on record in which only bilateral congenital fusion of the talonavicular joint was present, the other tarsal joints being normal. Review of the subsequent literature from 1932 to 1937 revealed only one more case of this apparently very rare malformation of the foot skeleton, that reported by Rothberg, Feldman, and Schuster.

In their patient, a girl, eight years old, bilateral talonavicular fusion was demonstrated in routine roentgenograms. Similar changes were discovered in the feet of the girl's brother, eleven years old, and also in those of her mother, thirty-one years of age. The boy had never had any foot trouble, but he likewise presented medial projection over the talonavicular region. The mother's feet appeared normal. This

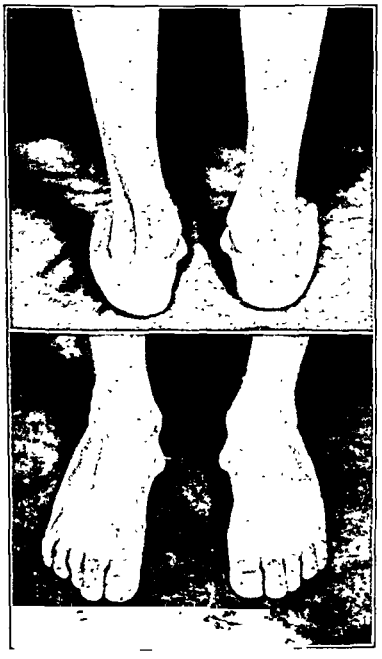


Fig. 1-A



Fig. 1-B

Photographs of feet, showing the bilateral large projection over the medial aspect of the talonavicular region.

*Service of Leo Mayer, M.D. †Service of Harry Finkelstein, M.D.

genographic evidence of Perthes' disease becomes manifest in hips following severe trauma indicates a more than casual relationship between the trauma and the subsequent development of Perthes' disease.

In treating cases of traumatic dislocation of the hip joint, the possibility of the development of an osteochondritis of the femoral epiphysis should be borne in mind.

While traumatic dislocation of a hip joint is rare, these six cases are additional evidence for the hypothesis of a traumatic etiology for Perthes' disease.

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case is most interesting, as it is the only one on record which definitely proves the condition to be congenital and also hereditary.

Recently another case has come under the author's observation, a report of which follows.

## CASE REPORT

E. C. (No. 63703), a colored girl, eleven years old, was brought to the Clinic of the Hospital for Joint Diseases on February 13, 1937, because of projections over the medial aspects of both feet. The condition had been present since infancy and, outside of occasional pressure symptoms from the shoes, had given her practically no discomfort.

None of the members of her family were known to have any foot deformity. Her past history was irrelevant, except for recurrent enlargement of lymph nodes on the left side of the neck. She was operated upon for this condition in July 1937, and a diagnosis of tuberculous lymphadenitis of the left cervical superficial nodes, with cold abscess formation, was made.

The patient was a tall, undernourished, colored girl with long, thin limbs. Upon examination, the general physical findings were essentially negative except for the tuberculosis of the left cervical lymph nodes. The blood Wassermann test was negative. Her feet were of the long, narrow type with very marked pronation and complete obliteration of the longitudinal arches. There was a bilateral projection about the size of a cherry on the medial aspect of the talonavicular region. (See Figures 1-A and 1-B.) This consisted of a bony prominence with fibrous subcutaneous enlargement appearing as a bursa. The skin over it was covered with a callosity, but there was no tenderness present. The posterior part of each heel did not come in contact with the ground, the sole giving the impression of a rocker bottom.

Dorsiflexion of the feet was possible to about 25 degrees. Hypermobility was also noted in all of the other joints of the foot except for marked restriction of lateral motion of the forefoot over the back foot. All motions were completely painless. There was good pulsation of the arteries of both feet. Motion of the toes was normal. The roentgenograms of the feet, in the dorsiplantar view, showed complete absence of joint space between the talus and the navicular. The medial part of the talonavicular bone was markedly prominent, and there was considerable soft-tissue enlargement over it. The sesamoids of the big toes were not yet ossified. A linear density could be seen in the lateral view of both feet in place of the talonavicular joint which failed to develop. Marked planus deformity was also demonstrable. (See Figures 2-A and 2-B.) The roentgenograms of the patient's hands revealed nothing unusual. The mother's feet were normal on clinical examination, but, unfortunately, no roentgenograms could be obtained.

The patient was admitted to the Hospital and, on March 27, 1937, under general anaesthesia, the projecting parts of the talonavicular bones were shaved off. There was no definite subcutaneous bursa found during the operation.

The pathological examination of the removed bone revealed normal bone structure and was reported by Dr. H. Jaffe as showing "nothing illuminating".

The patient made an uneventful postoperative recovery. When seen in follow-up, about nine months after the operation, she stated that her feet gave her no discomfort. The planovalgus deformity, of course, was still present.

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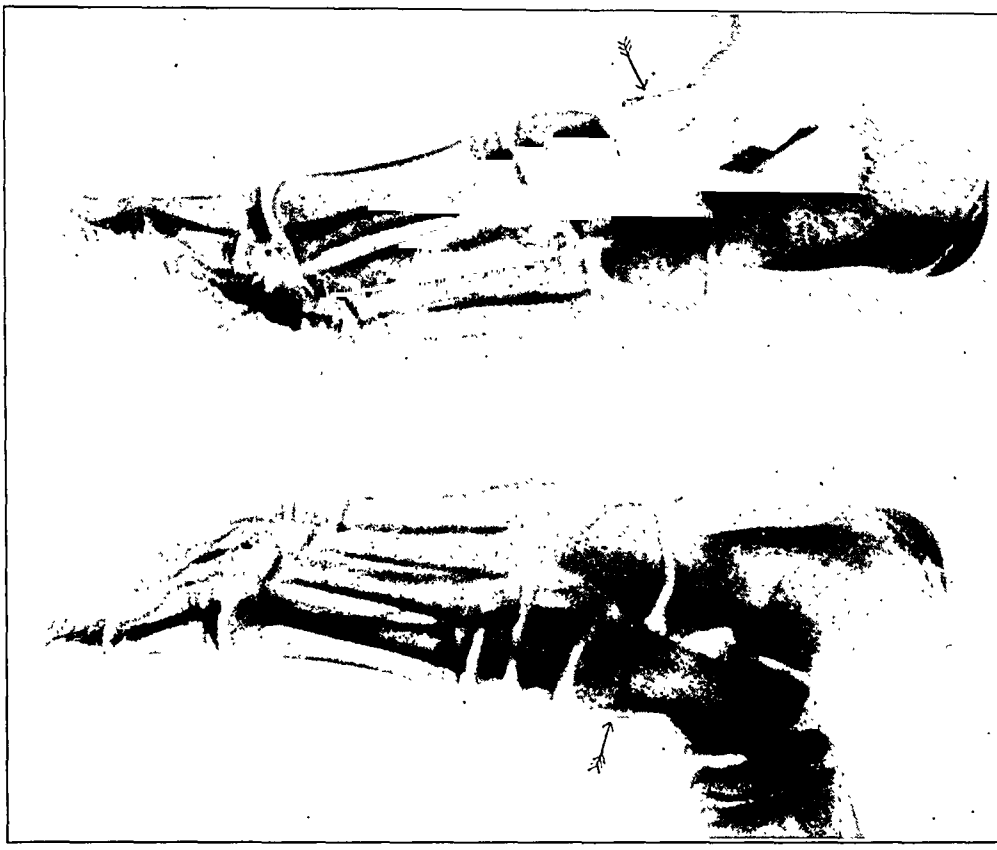


FIG. 2-B

Lateral view. The arrow points toward a linear density on the site of the talonavicular joint which failed to develop.

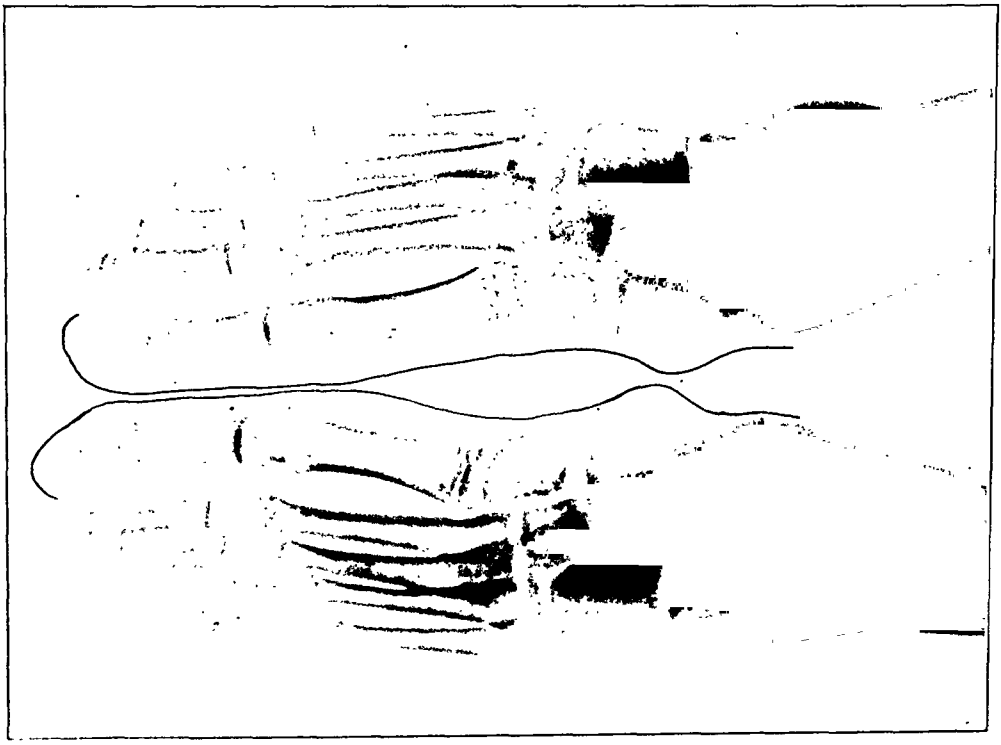


FIG. 2-A

Dorsiplantar roentgenogram of both feet. The outline of the soft-tissue shadow is retouched.

The splint herewith described was suggested by one shown in Truesdell's book on birth fractures. The only objection to Truesdell's appliance is that it is made of wood and it is somewhat cumbersome and inconvenient, particularly for nursing; nevertheless, it seems to embody the correct principles for the treatment of this fracture.

The splint which has been devised by the author is lighter and more convenient; it is constructed of materials and with tools which are available almost anywhere; and it can be made to the exact dimensions of the patient in a very short time.

The materials required consist of one piece of heavy tin or aluminum of moderately heavy gage; one piece of strap iron, three-eighths or one-half of an inch thick and about forty inches long; and four short bolts, one-eighth of an inch in diameter, and nuts or rivets. The only tools which are necessary are a pair of tin shears, a hand or electric drill, and a hammer.

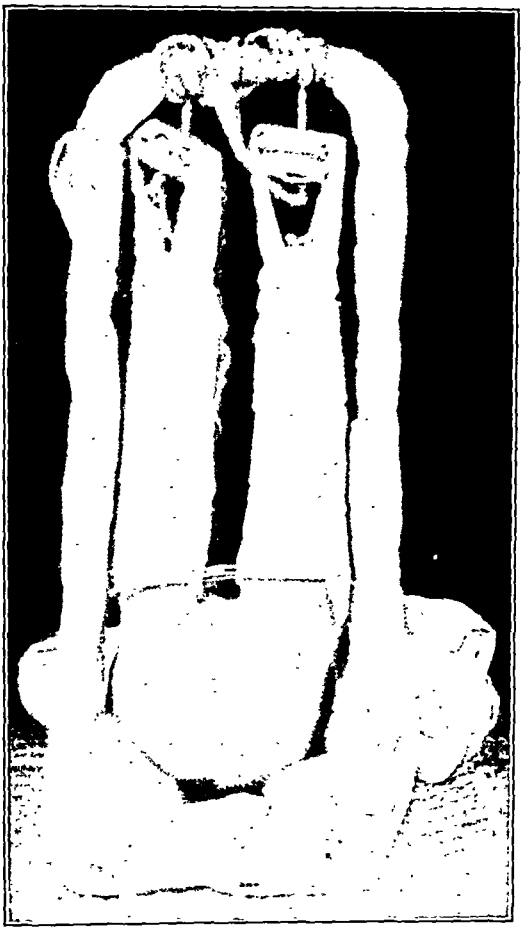


FIG. 2

Overhead traction splint. Note that the patient's buttocks are suspended above the surface of the bottom of the splint.

The infant is laid on the sheet of tin or aluminum with the buttocks at one edge, and the tin is marked with a pencil where the sides are to be bent up. Another pencil mark at right angles is made one inch beyond the head. The patient is then removed, and the sides of the sheet are turned up and cut off, so that they are two inches high. The upper six or eight inches of the sides are trimmed down to a height of one inch. All corners are snipped off or bent down. The strap iron is bent into rectangular form and, after holes have been drilled, it is bolted to the tin at its lower end at an inclination of about 10 degrees toward the top. Moleskin adhesive straps are applied to both of the patient's legs in the usual manner. The appliance is padded, and the padding is held in place by a bandage which, for the sake of appearance, is also continued

# TREATMENT OF BIRTH FRACTURES OF THE FEMUR

BY WILTON H. ROBINSON, M.D., PITTSBURGH, PENNSYLVANIA

This fracture occurs so rarely that when it does there is usually lacking an appliance for proper efficient treatment. Since the time when Credé recommended bandaging the broken leg to the front of the infant's body, many types of splints and appliances have been used. Silver was among the first to suggest an appliance for overhead traction. He modified the Bradford frame by adding a vertical post surmounted by a short horizontal piece to which the leg was suspended. Sir Robert Jones advised the Thomas splint. Fiske has used an inclined plane with weight traction. Schanz recommends an appliance which incorporates a heavy vertical wire (resembling a Thomas splint) into a posterior plaster shell. Rydén uses the same principle, but in his apparatus the vertical member is a Z-shaped piece with a pulley for weights on the upper horizontal part.

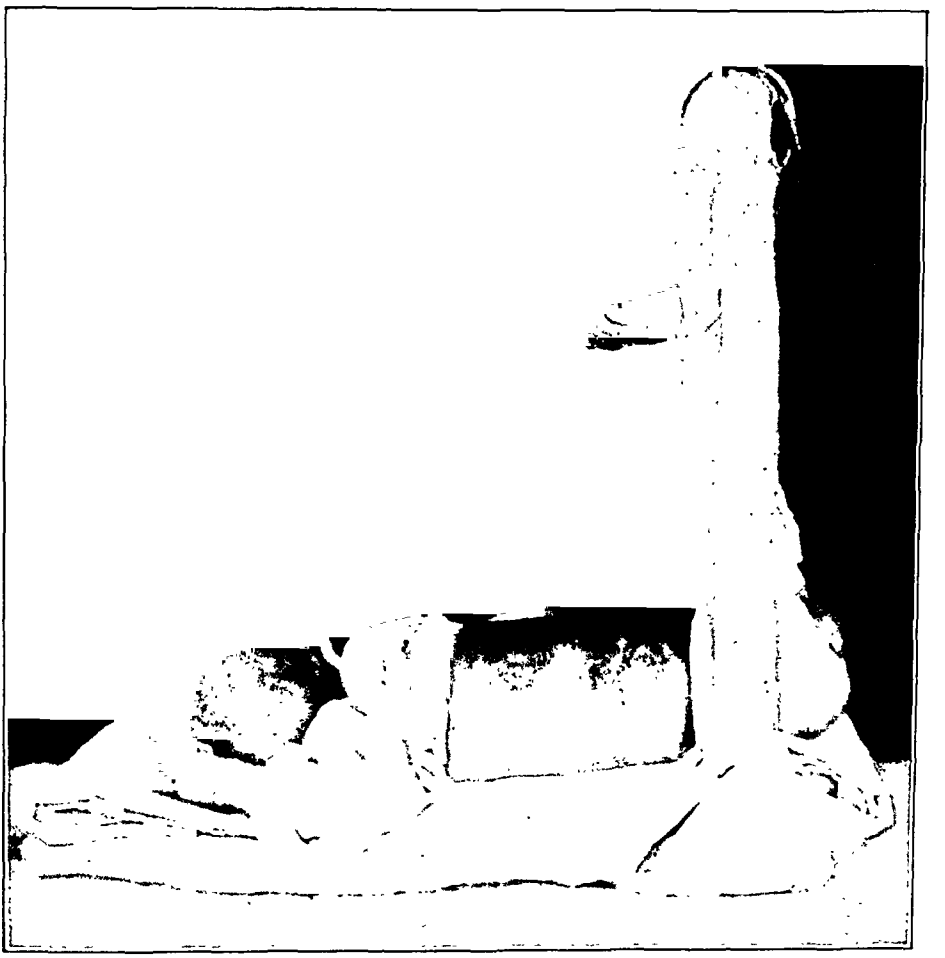


FIG. 1

Overhead traction splint. Note the piece of sheet lead on the child's abdomen to increase the amount of pull on the legs.

# A CAP TO PROTECT THE ENDS OF STEINMANN PINS

BY ROBERT MAZET, JR., M.D., OYSTER BAY, LONG ISLAND, NEW YORK

It has been apparent for some time that the usual methods of protecting hands, clothing, and bedclothes from the sharp points of Steinmann pins by placing corks over their ends, or by winding plaster about them, are not completely satisfactory. Corks invariably come off, and plaster is unsightly and difficult to remove entirely when one wishes to withdraw the pin.

We have been using on the Orthopaedic Service of the Meadowbrook (Nassau County) Hospital for six months the cap shown in Figure 1. It has proved itself eminently satisfactory from the viewpoint of nurses, patients, and surgeons. It is simply made and easily applied; it gives adequate protection; it does not come off; and it is readily removed by the surgeon, leaving a clean end to be passed through the tissues on withdrawal of the pin. It also prevents the point of the pin from being dulled by contact with hard objects.

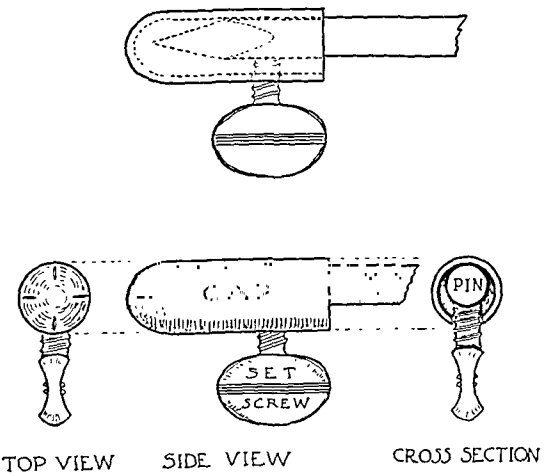



FIG. 1

The caps are made by the Engineering Department of the Hospital from brass rods in two sizes, the inner diameters being four and five-tenths millimeters and seven millimeters. The smaller caps are three-fourths of an inch in length; the larger, one inch in length. The brass rods are cut in sections a little longer than the desired length, and one end is then hammered closed. (Some of the caps have been made by cutting the rod the desired length and closing one end with solder.) A hole is drilled near the open end and threaded, and a set screw is fitted to the thread.

The open end is placed over the point of the Steinmann pin in the operating room, and the set screw is firmly tightened. The cap remains in place until unscrewed by the surgeon when it is time to remove the pin.

over the extension member. The patient is then placed on the appliance with the buttocks suspended about two inches and with both feet on the same level. In the case of a light-weight infant, a piece of padded sheet lead may be placed over the abdomen to give additional traction. If more than the countertraction of the child's body is desired, a pair of pulleys may be attached to the top of the overhead frame, so that the traction cords may be attached to weights or elastic traction may be placed at the side of the uprights.

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# CHONDRODYSPLASIA (OLLIER'S DISEASE)

## A Report of a Case Resembling Osteitis Fibrosa Cystica *

BY GEORGE H. SANDERSON, M.D., F.A.C.S., STOCKTON, CALIFORNIA, AND FRANCIS SCOTT SMYTH, M.D., SAN FRANCISCO, CALIFORNIA

*From the Crippled Children's Clinic, Stockton, and the Department of Pediatrics, University of California Medical School, San Francisco*

The present concept regarding parathyroid pathology in generalized bone disease was discussed by one of the authors in a recent report of osteitis fibrosa cystica. It is the purpose of this paper to report conditions where the resemblance of chondrodysplasia to osteitis fibrosa cystica might lead to confusion as to the diagnosis.

### HISTORICAL REVIEW

Ollier, in 1899, first described a case of a cartilaginous dystrophy in which the extremities of one side of the body were involved. In 1900, his pupil, Molin, described three similar cases,—two of Ollier's and one reported by Nové-Josserand and Destot. In one of these cases, instead of the "hemiplegic" distribution, there was a crossed distribution, the right lower and left upper extremities being involved. Since that time a number of contributions on this condition have appeared. Bentzon, in 1923, described lesions confined to the right lower extremity. He did experimental work on rabbits, injecting irritants near the nutrient arteries of the tibia and the fibula, and developed the theory that Ollier's disease may be interpreted as the typical reaction of the bones to an active hyperaemia of the bone tissue, resulting from anomalies in the sympathetic nervous system. However, it is generally felt at the present time that the etiology of this condition is unknown.

Ollier's disease has been frequently confused with multiple cartilaginous exostoses (also called "dyschondroplasia" and "diaphyseal aclasis") and has been regarded by some as the same disease. However, no good reasons have ever been stated for this claim. Diaphyseal aclasis has a hereditary history in 65 per cent. of the cases, whereas in Ollier's disease this history is almost universally absent. The distribution and morphology of the lesions are also entirely different and bear only the slightest resemblance to Ollier's disease. A number of cases have been reported, the nature of which cannot be accurately defined at present, but which are probably an intermediate type. Ollier's disease is characterized by the presence of areas of cartilage in the shafts of the long bones, especially near their rapidly growing ends, which in roentgenograms have the appearance of gouged-out areas, while in other places there seem to be

* This study was aided by a grant from the Christine Breon Fund, University of California.

# A LEG HOLDER FOR HIP NAILING

BY ROBERT CRAWFORD ROBERTSON, M.D., CHATTANOOGA, TENNESSEE

On numerous occasions the author has felt the need for mechanical fixation of the extremities during "blind" hip-nailing procedures. Leg-holding by assistants has in several instances resulted in change of the angle of femoral rotation to such a degree that accurate insertion of the nails has been difficult, and the operation has been needlessly prolonged. To meet this need, the apparatus shown in Figures 1 and 2 has been devised. It has proved so satisfactory that it is reported with the hope that it may be of value to others.

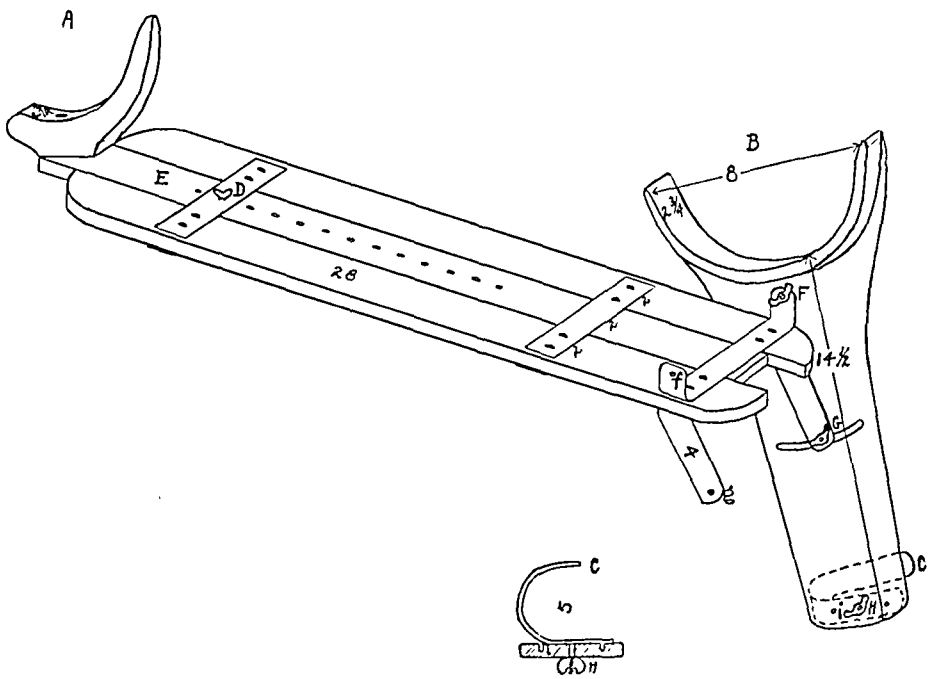



FIG. 1

Working drawing of leg holder assembled for nailing of the right hip, seen from above and from the right rear. Insert shows cross-section through half band of the leg. Dimensions given are in inches.

The holder is made of wood, three-quarters of an inch thick, and strips of strap iron one inch wide. It is placed across the stretcher or operating table with the stirrups *A* and *B* immediately proximal to the level of the knee joints of the patient. Preceding reduction of the fracture, the uninjured hip is completely abducted with the knee flexed at 90 degrees over stirrup *A*. This partially fixes the pelvis, which is further fixed by an assistant during the manipulative reduction. Following reduction, the desired angle of abduction is maintained by placing removable pin *D* in the desired hole in the sliding bar *E*, while the desired angle of internal rotation is maintained by rotating stirrup *B* at pivot *F*

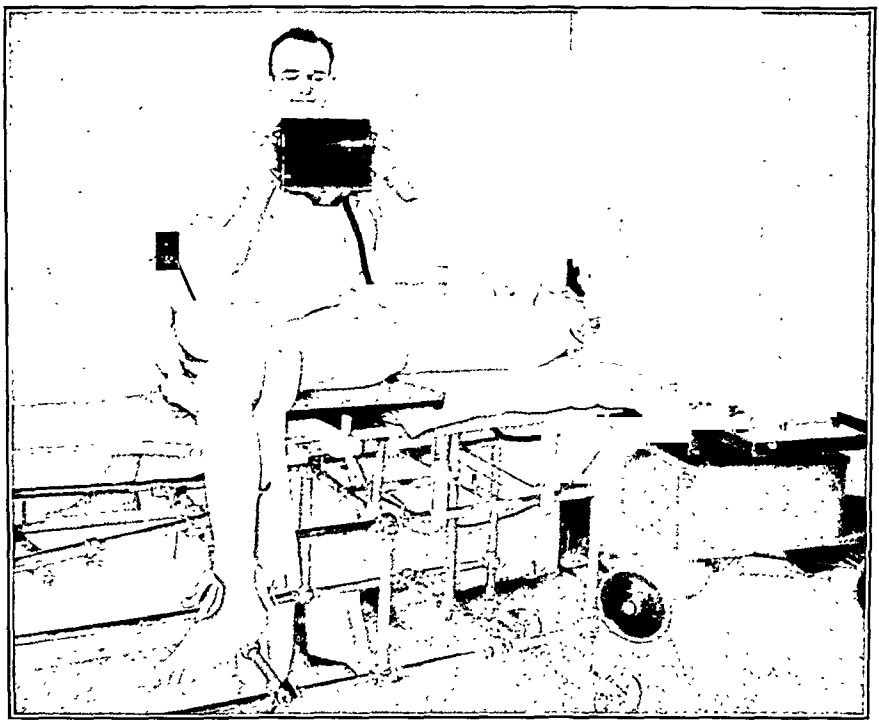


FIG. 2

Leg holder in use (without drapes), showing portable x-ray for anteroposterior view of the left hip. Vertical views are easily taken without change of position by placing the cassette against the lateral side of the thigh and the pelvis, with oil-immersion tube between the abducted thighs.

and locking with wing nut *G*. The knee of the fractured side is then flexed at 90 degrees over stirrup *B*, and the leg is engaged in the semicircular holder *C*. The supporting surfaces of stirrups *A* and *B* are wide, and, together with holder *C*, are heavily padded while in use. Either one or both of the extremities may be easily freed, or their position changed as desired. No interference is offered to portable roentgenograms made in "both views", or to operative procedure on the hip.

For use on the opposite extremity, the wing nuts *F* and *G* are unscrewed, and their bolts, together with the wooden attachment, are removed and reinserted through holes *f* and *g*. The wing nut *H* is loosened; holder *C* is rotated through an arc of 180 degrees and its locking pin is engaged in hole *i;* and the wing nut is tightened. Stirrup *A* is pivoted and may be rotated to the desired angle.

The holder is so constructed that both stirrups and the half band of the leg can be disjointed for transportation. Its construction is simple, and it can be made by any good mechanic.

The author is indebted to Mr. Omar W. Arnold, Chief Engineer of Baroness Erlanger Hospital, for the technical skill employed in constructing this device.

# ORTHOPAEDIC SURGEON'S UTILITY AND PLASTER CART

BY VOIGT MOONEY, M.D., PITTSBURGH, PENNSYLVANIA

The accompanying illustrations show a utility and plaster cart which has been used with much satisfaction by the author in the Allegheny General Hospital, Pittsburgh. These two views of the cart give a hint as to its usefulness and to the economy of space when it is closed. It measures forty-four inches by sixteen and one-half inches by forty-five and one-half inches, and is constructed from 26-gage sheet metal and one-inch angle iron.

Because of its compactness and arrangement, it makes for greater efficiency and affords economy of motion on the part of the operator. The fact that it may be closed and locked assures one that the supplies contained therein will be available when next needed. Its movability provides an added feature in that it may be shifted easily from one operating room to another.

The cart contains the following standard equipment and usual materials employed in the application or removal of a plaster-of-Paris cast:

1. Two cast knives.
2. One cast-knife sharpener.
3. One cast spreader and brace wrenches.
4. One pair of heavy-felt scissors.
5. Two pairs of bandage scissors.
6. A large piece of black felt.
7. A silence cloth cut in strips, four inches by thirty inches.
8. Wooden wedges for spreading casts.
9. Large corks and a variety of small nails.
10. Wooden tongue depressors and applicators.
11. Four pine plaster boards, nine inches by four inches by one-quarter of an inch.
12. One syringe for moistening casts.
13. Petrolatum to grease attachments to the Hawley table.
14. Two Allegheny-metal buckets (three and one-half gallons, each).
15. Sheet wadding:
    Six inches by six yards.
    Four inches by six yards.
16. Plaster-of-Paris bandages:
    Six inches by six yards—weight, ten ounces.
    Four inches by six yards—weight, eight ounces.
17. Gasoline, ether, alcohol, and tincture of iodine.
18. Ichthyol and collodion.
19. Mercurochrome (aqueous solution) 5 per cent.
20. Gauze, muslin, and flannel bandages.
21. Roll of adhesive tape.

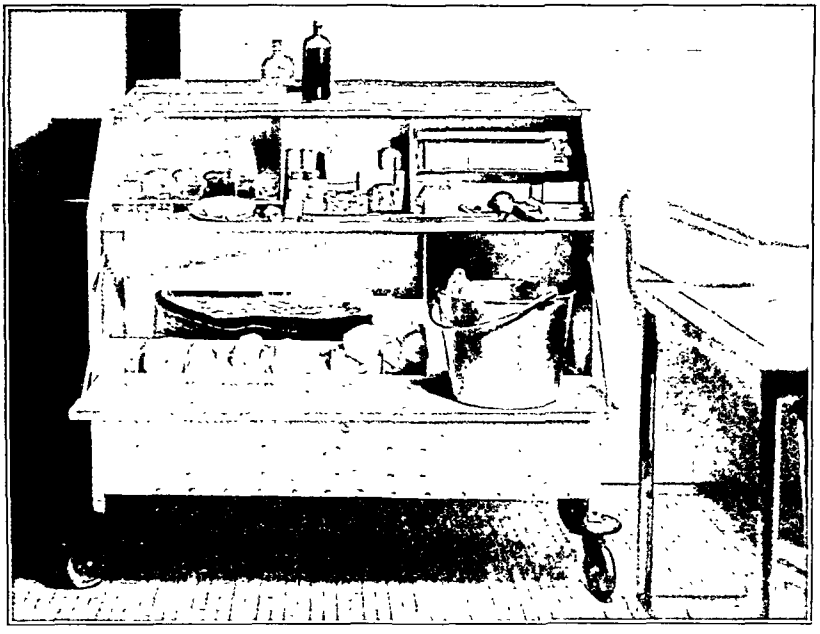


FIG. 1

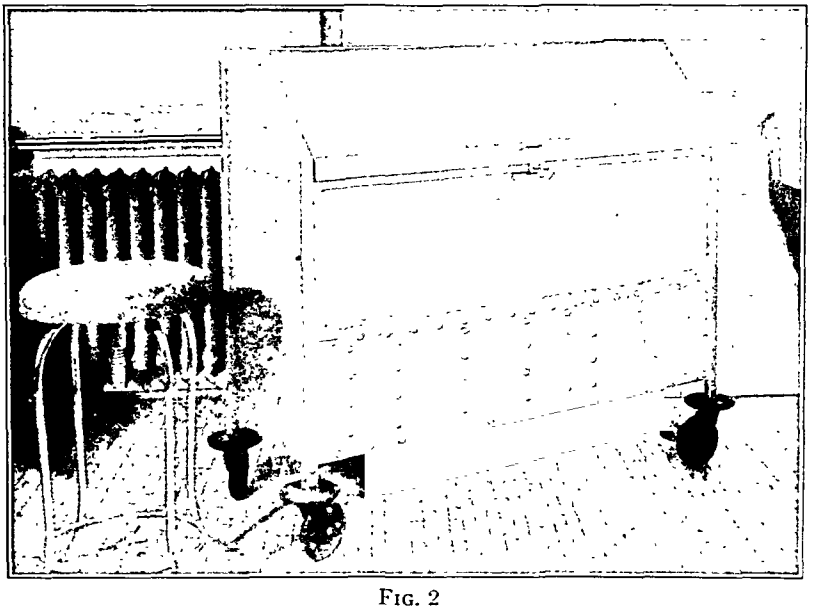


FIG. 2

22. Three different sizes of safety pins.
23. Talcum and stearate-of-zinc powder (one can of each).
24. Dressings and sterile applicators.
25. Rubber sheet and pillow.
26. Tape measure.

This list is affixed to the interior of the cart where the nurse in charge may consult it and quickly replenish the used supplies.

# A PIN AND STIRRUP FOR FINGER AND TOE TRACTION

BY EDWARD N. REED, M.D., F.A.C.S., SANTA MONICA, CALIFORNIA

When fingers or toes present compound fractures or fractures and contaminated open wounds, it is often necessary to apply traction which will not interfere with the treatment of the open wound. Such traction is best applied by a wire passed through the pad of the terminal phalanx. When a flexible wire is used, it produces discomfort from pressure on the sides of the pad; it also causes a marked atrophy of the pad, if the traction is kept up for several weeks,—probably because of the ischaemia produced by the lateral pressure of the wire. Several cases have been observed in which this atrophy is apparently permanent, and it is quite unsightly.

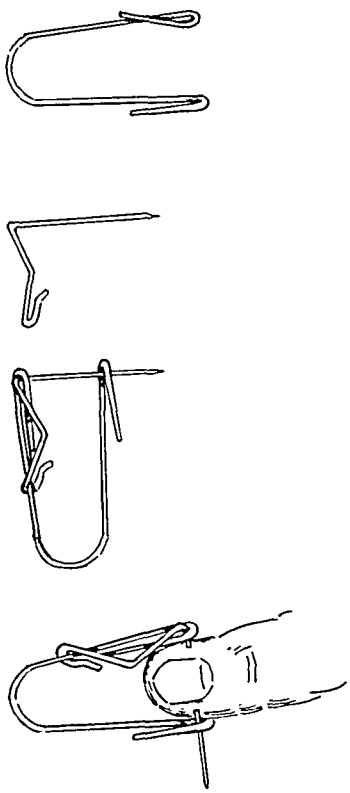


FIG. 1

Where a stiff wire or pin is used, which does not sag and so produce lateral pressure, the traction is not extremely uncomfortable and atrophy of the pad is not so apt to occur. Stirrups for connection between the pin and the traction rubber are readily made of wire and have long been in use. The difficulty with using them is to fix the pin in the stirrup so that it cannot slip sidewise and become disengaged from the stirrup. Adhesive has been used to wrap the ends of the pin, but this is apt to slip off; moreover it is cumbersome to apply in the small space available, and becomes fouled with discharges from infected wounds, making it difficult to keep the dressing sterile.

The pin and stirrup here illustrated overcome these difficulties. The straight end of the pin has a three-sided point ground on it, which readily pierces the pad. The other end of the pin has a loop which snaps over the side of the stirrup and which will not come undone except by a deliberate attempt. This snap loop, together with the angular bend in the short arm of the pin, prevents lateral slipping in either direction. After the pin has been inserted through the pad, the stirrup hooked over it, and the pin snapped in place, the pointed end is cut off with a wire cutter a little beyond the stirrup.

Both pins and stirrups are made of silichrome steel wire (18–8 stainless, hard drawn, 50/1000 of an inch thick), such as is used for making Kirschner wires. The snap loop is bent so that the entrance is a little narrower than the diameter of the stirrup wire, beyond which narrow neck the end of the wire flares out a little. The wire is very springy and the loop can be snapped onto the side of the stirrup by firm pressure and will remain in place until reverse pressure is put on it.

# News Notes

The Fifty-Second Annual Meeting of the **American Orthopaedic Association** was held at the Ambassador Hotel, Atlantic City, New Jersey, on May 2, 3, 4, and 5, under the presidency of Dr. Frederick C. Kidner. This meeting was held in conjunction with the Fiftieth Congress of American Physicians and Surgeons, since the American Orthopaedic Association is one of the component organizations.

With only slight changes, the program as published on page 514 of the April issue of *The Journal* was followed. Mr. T. P. McMurray, of Liverpool, was the guest of honor and presented an important paper on "Osteo-Arthritis of the Hip".

The Annual Dinner of the Association was held on Wednesday evening, May 4, and the reception for members of the Congress took place on Tuesday evening, May 3. Joint sessions with the Congress were held on Tuesday evening and on Wednesday afternoon.

The Association met in Executive Sessions at noon on Tuesday, May 3, and Thursday, May 5, when the business of the Association was transacted.

Elected to active membership in the Association were the following:

E. J. Berkheiser, M.D., Chicago, Illinois.
Edwin F. Cave, M.D., Boston, Massachusetts.
C. H. Crego, Jr., M.D., St. Louis, Missouri.
Herman F. Johnson, M.D., Omaha, Nebraska.
Sumner M. Roberts, M.D., Boston, Massachusetts.

Dr. Frank D. Dickson, Kansas City, was chosen President for the year 1939–1940.

The officers for 1938–1939 are as follows:

President: William Ward Plummer, M.D., Buffalo, New York.
President-Elect: Frank D. Dickson, M.D., Kansas City, Missouri.
Vice-President: W. Barnett Owen, M.D., Louisville, Kentucky.
Treasurer: John L. Porter, M.D., Evanston, Illinois.
Secretary: Ralph K. Ghormley, M.D., Rochester, Minnesota.

The following Members of Committees and Delegates were elected:

Member of Membership Committee: Edward L. Compere, M.D., Chicago, Illinois.
Member of Program Committee: Alan DeForest Smith, M.D., New York, N. Y.
Representatives on the American Board of Orthopaedic Surgery: George E. Bennett, M.D., Baltimore, Maryland, and Charles W. Peabody, M.D., Detroit, Michigan.
Delegate to the American College of Surgeons: James Archer O'Reilly, M.D., St. Louis, Missouri.
Delegate to the Congress of American Physicians and Surgeons: J. Torrance Rugh, M.D., Philadelphia, Pennsylvania, re-elected.

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Dr. Leo Mayer has moved his office from 140 West 79th Street to 1150 Fifth Avenue, New York City.

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Dr. Richmond Stephens announces the removal of his office to 333 East 43rd Street, New York City.

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Dr. Athey R. Lutz has opened an office at 1044 Market Street, Parkersburg, West Virginia.

every speaker agreed that it is a disease of steadily diminishing incidence and numerically is now of minor importance. However, several authorities maintained that its peculiar features are no better understood now than they were at the time of Sydenham's classic description. The chairman of the Section on Gout, Prof. F. R. Fraser, suggested that already the biochemists have provided all the bricks for the explanation of this mysterious disease, and it only awaits the genius of an architect to put them together. It was agreed that the relief came from those agents which increase elimination rather than destroy uric acid and that the gouty patient suffers from congenital or acquired difficulty in excreting purins. Determinations of uric acid of the blood are important. There may be chronic rheumatism of gouty origin, particularly osteo-arthritis of the knees and of the lumbar spine. There is a hereditary factor, possibly a transmitted allergic state, and there is also a gouty fibrositis. Prof. Gibson found that of the patients with true gout 11 per cent. were women and 24 per cent. had a familial history of gout; also, the onset was acute with complete intermission in 75 per cent. of the cases. An injury, infection, or worry preceded gouty attacks, as in other rheumatic conditions. He believes that gout is a form of rheumatism which takes place in a person with a particular defect in metabolism. The sedimentation rate is increased in 59 per cent. of the patients with gout.

Only a short morning session was given to the urgent subject of rheumatoid arthritis, and in this no reference was made to its orthopaedic aspects—such as the prevention of deformity, or the place of splinting in its treatment—or to the admirable effects of occupational therapy in increasing the morale and physical independence of sufferers, even in neglected cases. Three very interesting papers were given, but the limited time only allowed a narrow approach to a great subject and cut out nearly all discussion. Dr. Pemberton gave an interesting account of experimental studies of the circulation in arthritics, showing that in 75 per cent. the peripheral circulation had a lowered response to changes in external temperature and also decreased rates of tissue exchange, particularly for glucose and oxygen. Associated with these was accumulation of fluid in the tissues, possibly due to increased permeability of the capillary walls. He suggested that there are many circulatory deficiencies in arthritis produced by certain primary agents, but that some of the symptoms could be referred to the circulatory changes which are at first functional, shown in decreased rates in exchange of materials between tissues and blood, as evidenced in the low metabolism, decreased sugar removal, increased percentage of saturation of intravenous blood with oxygen, and increased range of vasomotor response following exposure of the body to low temperatures. Therapy should be directed toward these deficiencies and emphasis placed on the broad approach to the patient as a whole. Dr. Hench read a paper on the physiological effects of jaundice. Striking cases were described in which intercurrent attacks of severe jaundice, artificially produced, had resulted in remission or temporary cure of rheumatoid and fibrositic changes, although the latter had tended to relapse after the jaundice had subsided, the period of relief being two or three times the length of the attack of jaundice. Regardless of the supposed validity of the infection theory, rheumatoid and fibrositic changes can be profoundly influenced by a phenomenon primarily chemical. Prof. Davidson pleaded for an organization like that which has been so successful in Britain in dealing with crippling conditions in childhood,—that is, new central hospitals associated with scattered clinics, the latter staffed by trained specialists paid by the State. He recognized that sufficient numbers of such specialists are not available at the present moment and he pleaded for a postgraduate school for their education. He did not call attention to the fact, however, that a considerable number of the cases, which the profession at large calls "rheumatic" and which swell the government statistics, are already receiving satisfactory treatment in the present orthopaedic clinics and hospitals.

## BRITISH ORTHOPAEDIC ASSOCIATION

The Spring Meeting of the British Orthopaedic Association was held in London and Oxford on May 27 and 28 under the presidency of Mr. Naughton Dunn. There were a

large number of guests from the Scandinavian countries, among them Dr. Guildal of Denmark, Prof. Waldenström of Sweden, and Dr. Plato of Norway. The Association Dinner was held at the Langham Hotel, at which, in addition to the Scandinavian guests, there were present Prof. Maffei of Brussels and Dr. Leveuf of Paris. There was also a dinner in New College, Oxford, at which Viscount Nuffield was present and addressed the Association.

One whole day was spent at the country branch of the Royal National Orthopaedic Hospital at Stanmore, and at the Wingfield Morris Hospital at Oxford. Clinical demonstrations at both hospitals covered a wide range of deformities and diseases, tuberculous and non-tuberculous. The excellent departments for occupational training aroused great interest.

During the Meeting the following short papers were presented:

*Distribution and Treatment of Extra-Articular Foci in Tuberculous Arthritis of the Hip Joint* by Mr. J. A. Cholmeley, London.

The case histories of fifty-five children, treated for tuberculous foci in the neighborhood of the hip, at the country branch of the Royal National Orthopaedic Hospital, were carefully reviewed. In forty-three patients conservative treatment had been employed and in twelve the focus had been excised. In a large majority of the cases, the hip joints became involved eventually, and less than 10 per cent. of the children escaped with movable hip joints. The conclusion was drawn that attempts to excise extra-articular foci had no advantages over conservative treatment.

*Structure and Function in Synovial Joints* by Mr. M. A. MacConaill, Sheffield.

In this paper Mr. MacConaill elaborated the remarks which he had made to the Association in October on the principles of Joint Mechanics. He outlined the relation and adaptation of joint function to its lubrication—the synovial fluid—and gave a detailed account of the structure and function of ligaments. He ended by describing several joints in detail in the light of his researches. Mr. MacConaill has stimulated great interest in this problem.

*Osteochondritis of the Adult Tarsal Scaphoid* by Mr. J. F. Brailsford, Birmingham.

This paper gave details of nine cases of osteochondritis of the scaphoid occurring in adult women, and affecting both feet. The characteristic lesion is an oblique splitting of the scaphoid and separation of the two fragments. The outer smaller fragment is displaced dorsally; the inner larger fragment displaces gradually and comes to lie on the *mesial* aspect of the head of the astragalus. Subsequently, gross osteo-arthritic changes develop in the midtarsal joint.

*An Operation to Restore Opposition of the Thumb* by Mr. F. G. Allan, Birmingham.

Mr. Allan reviewed the histories of forty-three patients on whom he had operated to restore opposition of the thumb. The procedure consisted of inserting a tibial graft between the index and thumb metacarpals so that the thumb was maintained at right angles to the palm. The operation was applicable to both flaccid and spastic paralyses. Very marked improvement in the function of the hand resulted in all but one of the patients.

*Arterial Occlusion in Relation to Volkmann's Contracture* by Mr. D. L. Griffiths, Manchester.

From a review of the literature and of clinical material, and from his experiences with emboli, Mr. Griffiths argued that the "venous obstruction" theory was no longer tenable as a cause of Volkmann's contracture, and that the bulk of the evidence was in favor of arterial obstruction. He cited two cases in which, following occlusion of the femoral artery by a proved embolus, changes, in every way similar to those associated with elbow and forearm fractures, occurred in the calf muscles. A plea was made for a more careful recording of these cases, especially such facts as the presence or absence of the radial pulse. Mr. Griffiths considers it likely that the only effective treatment is operation, which should include liberal opening of the deep fascia and inspection of the brachial

artery. Periarterial sympathectomy and arteriectomy have in the main been disappointing.

*A Preliminary Account of a Method of Arthrodesis for Healed Tuberculosis of the Hip* by Mr. H. A. Brittain, Norwich.

The operation, illustrated by a film, consists in performing a short oblique subtrochanteric osteotomy, displacing the distal fragment inward until its upper end comes into contact with the ischium over an area which is "rawed" with a special osteotome. If the hip is adducted, the procedure can be carried out "blindly" through a limited anterolateral approach. If abducted, the classical posterior approach is employed. It is claimed that this "ischio-femoral arthrodesis" is a much sounder mechanical procedure than the usual ilio-femoral arthrodesis. In either approach, the operation can be performed well away from the diseased joint. Reports were given on eight patients who had been observed for at least two years since operation. The functional results were excellent and there had been no recurrence of the disease.

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## CORRECTION

Our attention has been called to the fact that in the article entitled "A Bone Plate Which Will Not Break or Bend" by Dr. George W. Hawley and Dr. Ralph D. Padula, published in the April issue of *The Journal* (Vol. XX, page 469), reference should have been made to the following:

Souttar, H. S.: A Method for the Mechanical Fixation of Transverse Fractures. Ann. Surg., LVIII, 653, 1913.

Speed, Kellogg: A Discussion of Pott's Fracture with Complications: Based on a Series of 208 Cases. Surg. Gynec. Obstet., XIX, 73, 1914.

Speed, Kellogg: A Text-Book of Fractures and Dislocations with Special Reference to Their Pathology, Diagnosis and Treatment. Ed. 1. Philadelphia, Lea & Febiger, 1916.

The authors wish to acknowledge the priority of the principle of the flange plate which is presented in these articles. The omission of reference to them was entirely due to an oversight and is regretted by the authors.

# Current Literature

DIE ERNÄHRUNGSBEHANDLUNG IN DER CHIRURGIE (Dietotherapy in Surgery). Dr. Arno Siller. (Vorträge aus der praktischen Chirurgie, 21. Heft.) Stuttgart, Ferdinand Enke, 1938. 2.20 marks.

In this monograph of forty pages, Dr. Siller, physician in charge of nutrition at the Institute in Isny of the Surgical Clinic of the University of Munich, describes the attempts that have been made to influence the course of surgical tuberculosis through diet. This work received impetus through the early studies of Gerson who believed that the pathological conditions in chronic inflammatory disease could be modified by special feeding; particularly, that an abundance of sodium chloride was harmful. Gerson taught that wounded tissues heal better with an acid nutritional status than with an alkaline one. It is mentioned as a point of interest that Hippocrates advocated fasting for wounded persons, but permitted the drinking of water and vinegar. Hermannsdorfer observed in the last year of the World War, when meat was rare in the soldiers' rations and vegetables were used in abundance, that the healing of wounds was slower and that secondary infection of wounds, especially with the diphtheria bacillus, was common.

Studies were made of the hydrogen-ion content, the diphosphate and ammonia of the urine, the carbon dioxide in the alveolar air, and the alkali reserve of the blood. (The results are not given.) Finkelstein and Czerny, in 1905, had found an acid-producing diet of value in certain of the exanthemata of children. From these studies and the author's experience, a diet, called the Sauerbruch-Hermannsdorfer diet, was devised. This diet allows about fifty calories per kilogram of body weight and is almost a normal mixed diet. It is particularly rich in protein and in fats. All meats, except smoked, salted, and those highly spiced, are permitted. Sodium chloride and conserves are forbidden. All vegetables and fruits, as well as eggs, milk, cheese, and butter, are given freely. In addition, vitamin concentrates are given,—in this diet, 45 grams of "*phosphorlebertran*" a day. This diet is given at seven periods during the day.

This acid-producing diet, free from sodium chloride but containing an adequate amount of minerals and vitamins, has been used in Lexer's Clinic since 1928. It is probable that its effect is expressed through the sympathetic nervous system and the endocrine system. The only data that the author could obtain on the effect of this diet in the course of tuberculosis were clinical data. The author has submitted a table of the end results obtained in 290 patients suffering from surgical tuberculosis who have been discharged during the last three and one-half years. The author attempts to determine a mean period of stay in the Institute for the various forms of tuberculosis. He states that the diet has aided in arresting all forms of surgical tuberculosis more quickly, particularly tuberculosis of the skin and of the supportive tissues. Case histories are given to show the clinical course in a few types of surgical tuberculosis. When the diet was used for patients suffering from visceral tuberculosis, only slight improvement was observed. It was questionable whether the diet was of any value in pulmonary tuberculosis.

Much interesting clinical observation is recorded in this book. The author has had the opportunity to observe the patients over long periods. Diets with acid or alkaline residue have been used before for many years with the hope that the tissues of the body would become a soil unfavorable for bacterial growth, or that reparative processes would be hastened. It is unfortunate that laboratory data of changes in the tissues could not be secured, but the clinical observations suggest that dietotherapy can be of definite aid in combating certain chronic infections.

PEDIATRIC SURGERY. Edward C. Brenner, A.B., M.D., F.A.C.S. Philadelphia, Lea & Febiger, 1938. $10.00.

This volume, according to the author's statement in the preface, is an attempt to produce a text, neither encyclopaedic nor compendial in type, which may be of practical

value to those engaged in the study and practice of Pediatric Surgery. "Fractures, dislocations, and other orthopaedic conditions" are omitted, but there are short chapters devoted to "Developmental Diseases of Bone", "Benign Bone Growths", "Sarcoma of Bone and Bone Marrow", and "Brachial Birth Palsy". These chapters are quite inadequate and could have been omitted without detriment to the book. The chapter on "Infections of Bone" is fairly detailed, but is far from being completely up to date. There is no differentiation of the course of the disease as it affects infants and older children, and the terms "streptococcus" and "staphylococcus" are not mentioned. The reviewer found the chapters on "Anaesthesia" and "Preoperative and Postoperative Regimen" well done.

The format of the book is attractive, the typography is excellent, and there are nearly 300 illustrations.

MASSAGE AND REMEDIAL EXERCISES IN MEDICAL AND SURGICAL CONDITIONS. Noël M Tidy. Ed. 3. Baltimore, William Wood and Company, 1937. $5.25.

In this third edition of "Massage and Remedial Exercises", the author has covered in a thorough manner a very large field. The book can be of value to those, and only to those, who are familiar with and have had experience with the principles and the applications of physiotherapy, and the author undoubtedly presupposes this training. She covers the entire field of surgery and medicine in which this therapy could be used and gives indications for its employment,—the existing conditions for which it is used and the indications for the choice of the form of massage and physiotherapy which should be applied in each.

Chapters are devoted to surgical conditions, fractures, dislocations, sprains, and various diseases. Under each subject is given a brief statement on the etiology, symptoms, and pathological changes, with an outline of the principles and methods of physical treatment for this condition.

Special attention has been given in this new edition to the revision of the sections dealing with the methods of treatment, that they may include the changes which have recently come and have been accepted by the medical profession.

Of just how much value the consideration of the pathology and the surgical or medical treatment is in a book of this scope, is questionable, for such a consideration must necessarily be fragmentary and a clear understanding of this phase of the subject cannot be gained. Since it is generally accepted that the physical treatment should be given only under the direction of a medical attendant, an incomplete understanding of the condition is frequently misleading.

The exercises to be used are very clearly described and particularly well illustrated, and the directions to guide in the choice of therapy will be helpful, even to experienced physiotherapists. The author has evidently had an extensive experience in this special treatment and she has presented exercises and movements which can be used successfully and which will enlarge the scope of most workers in this field. The book will be a valuable guide to aid in the adaptation of the methods of physiotherapy to the various conditions in the rather extensive field which is covered by this book.

DIE KRIEGSSCHUSSVERLETZUNGEN DER GELENKE UND KNOCHEN DER GLIEDMASSEN (World-War Gunshot Injuries of the Bones and Joints of the Extremities). Prof. Dr. Karl Franz. (Vorträge aus der praktischen Chirurgie, 18. Heft.) Stuttgart, Ferdinand Enke, 1938. 1.80 marks.

This monograph brings the experience of the World War to bear on the subject of open fractures of the joints and of the long bones. It sifts out and presents the treatment which resulted in a mortality only one-tenth as great as that due to similar injuries in the Franco-Prussian War of 1870. Franz emphasizes above all else the element of infection,—its prophylaxis during the first twenty-four hours, the rigid aseptic technique re-

quired for open injuries of joints, and at the same time the value of not too radical surgery in the early treatment of gunshot fractures of the long bones (fractures which in general are less susceptible to secondary infection than the compound fractures occurring in civil life). Subsequent treatment of secondary infection must consider not only the preservation of life, but also measures which will reconstruct the injured joint and avoid pseudarthroses, especially in the lower extremity.

The author upholds the antiseptic attack on infected joints. Frank infection demands irrigation and drainage; this is to be combined with periodic, maintained, closed distension of the joint with phenol, camphor, and alcohol solution; transient irrigation is unavailing. Bactericidal solutions must act continuously in a joint for from twenty-four to forty-eight hours to be effective. Progressing infection demands wide exposure and often joint resection.

Franz points out that, although gunshot wounds of bone constitute compound fractures, conservative expectant treatment is in order when entrance and exit wounds are confined to the size of the projectile; when these wounds are larger, they should be débrided and left open. The most important principle in early treatment is the minimal disturbance of injured tissues compatible with avoidance of infection. Moderate subsiding infection can be aided by the now much neglected progressive secondary suture. Salve, containing 1.5 per cent. silver iodide and cod-liver oil, is useful in later treatment. Serum prophylaxis against tetanus and gas-bacillus infection is necessary. Delayed hemorrhage is treated by proximal arterial ligature. Thrombophlebitis requires venous ligature or resection. Necessary amputations should be carried out soon.

In this monograph the types and treatment of secondary infection are particularly well handled. The author's sound knowledge of the complications associated with bone and joint injuries is transmitted to the reader in a way that provides an unusually clear perspective of a subject which is too seldom accorded such a useful presentation.

EMERGENCY SURGERY. Hamilton Bailey, F.R.C.S. (Eng.). Ed. 3. Baltimore, William Wood and Company, 1938. $14.00.

This is a comprehensive book on emergency surgery. It is a third edition of 817 pages, with 816 illustrations, of which a large number are in color. The subject matter covers a wide range and is concisely treated, and, for the most part, the space allotted to the various topics is adequate and proportionate to their importance.

The book opens with excellent chapters on intravenous therapy, blood transfusion, anaesthesia, and the ordinary tools necessary for emergency surgery. There follow a fairly extensive but extremely informative group of chapters on emergency abdominal surgery. There is a tendency at times to apply the terms *always* and *never* to conditions open to differences of opinion. However, there is so much of excellence, and the text is so profusely and well illustrated, that this book cannot fail to prove of value to the surgeon engaged in emergency abdominal surgery.

The chapters on bones and joints are good as far as they go. The treatment of compound fractures is covered adequately, but simple fractures are entirely omitted. Dislocations are well illustrated, as is the treatment of septic joints. However, the Carrel-Dakin and Orr methods are only mentioned briefly in their relation to the treatment of compound fractures. The chapters on "Nerves and Tendons", "Lacerations and Mutilations of the Hand", and "Infections of the Hand" are all good.

A very valuable chapter is that on "Urgent Amputations". The best levels for amputation under varying conditions and the operative techniques are given. The illustrations are plain and well done. The subject of artificial limbs is discussed.

The book covers nearly every conceivable emergency. Although the surgeon who is interested in emergency surgery may encounter in its pages an occasional statement not in accord with his belief, there is much of value in this book to recommend it.

rounded cystic areas. Several authors, who have reported histological findings in portions of excised bone, are in agreement that the rarefied areas consist largely of hyaline cartilage.

Much has been made of the question of nomenclature, most authors stating that the term "Ollier's disease" should be reserved for cases which show an asymmetrical involvement, approaching a unilateral involvement, as an outstanding feature. This has been done in spite of the fact that in one of Ollier's original cases there was a crossed distribution affecting one leg and the opposite arm.

The case report which follows shows the symmetrical involvement of both legs and almost every bone in one arm. The other arm is free from involvement. This patient has been under observation at the Stockton Crippled Children's Clinic for the past five years. During this time roentgenographic studies have been made to follow the development of the disease. The case constitutes a connecting link between Ollier's disease, which involves only one side of the body, and chondrodysplasia, a term applied to the same condition when it involves both sides of the body symmetrically. Obviously, this case does not demonstrate that type of chondrodysplasia associated with cartilaginous exostoses. There has been a gradual increase in the degree of bone involvement during the five years in which the patient has been under observation, as well as some spread of the lesions to bones not apparently involved previously.

## CASE REPORT

F. S. was a well-developed, healthy appearing male. His birth history was negative and he had had no early disease. He had been artificially fed; after four months he had been given cereals, but no vegetables until he was eight or nine months of age. No antirachitic therapy had been given. His development appeared to be normal and his legs were straight until his third year. He was brought to the Stockton Crippled Children's Clinic at the age of four years and examined for the complaint of knock-knee. Roentgenograms of the knees then showed a frayed-out rachitic type of epiphyses with a peculiar cross-striated appearance of the ends of the diaphyses adjacent to the knees, and the lower ends of the femoral diaphyses looked gouged-out. The affection was first diagnosed as an unusual case of rickets. This was two years before the true condition was recognized. Subsequent roentgenograms showed involvement of each end of both tibiae and femora, characteristic radial striations in both ilia, involvement of two ribs on the right side, and of the right humerus, radius, ulna, and several phalanges and metacarpal bones. No involvement of any bone in the left arm was found, and the skull and spine were entirely negative. In 1932 the patient had a pathological fracture of the right femur, and a year later he sustained a second fracture in the same area. Both fractures healed in the usual time.

Physical examination of this patient at the age of eight years and eleven months, when admitted to the University of California Hospital, showed a well-developed and well-nourished boy, healthy and robust in appearance. He walked with a decided limp, and there was a definite though not severe genu valgum on the left and a moderate genu varum on the right. The latter was caused in part by a moderate outward bowing in the lower third of the right femur following the pathological fracture. The shafts of the femur were palpably enlarged. The head was normal in contour. There was a slight retardation in the development of the teeth. Examination of the ears, the throat, the neck, the heart, the lungs, and the abdomen was negative. The reflexes and neurological

wounds by secondary intention. The purpose of excision and prompt closure of accidental wounds is to convert their healing to that of primary intention. The technique and mistakes of early operative treatment are carefully described. When body cavities, such as joints or pleural spaces, are opened, the correct principle is to close the cavities, but to drain the overlying tissues. In primary closure, great care must be exercised to prevent infection from the adjacent skin; silver foil is most useful in achieving this object.

A bacterial survey of infected wounds is given. Earth-borne infection is often anaerobic and frequently combatable by antisera. Surgical injury of old or infected wounds should be avoided as much as possible. Attempts at interstitial antisepsis are misdirected. It is important to promote drainage and tissue transudation; granulated sugar provides an excellent osmotic agent. When salves are used, they should possess a fat base saponifiable by wound secretions. Burns are to be treated by resection of necrotic tissue and electrocoagulation of burned surfaces. Although no antiseptic application is superior to primary excision, the time-honored Chlumsky solution (alcohol 10 parts, camphor 60 parts, phenol 30 parts) is valuable in the treatment of joint infections. Contractures, ankyloses, and plastic defects may be treated after infection subsides.

Systemic effects of wounds are associated with mensurable changes in the proportions of the blood elements. The resorption products of wounds are inactivated by a temperature of 59 degrees centigrade, a fact favoring electrosurgery. The author recommends this type of surgery because the coagulation incision minimizes tissue necrosis; there is little or no operative shock; it causes less hemorrhage, and fewer ligatures are necessary; no cell transference is present; there is little postoperative pain; and healing is accelerated.

An appendix gives a list of supplies, medication, and sera. In all, von Seemen's monograph gives a clear and thorough exposition of the application of the best surgical principles to the care and treatment of wounds.

American Medicine. Expert Testimony out of Court. Edited and Published by The American Foundation, New York, 1937. Two Volumes, $3.50.

This work, in two bulky volumes, is an admirable example of a type of research which has become increasingly familiar in America, which we may term "research by questionnaire". It was undertaken by The American Foundation in order to obtain a representative expression of opinion from selected physicians throughout the United States on a variety of controversial subjects relative to the part which government should play in regulating medical practice and providing adequate medical care to the citizens of this country. Approximately two thousand doctors participated, and this report presents a digest and summary of their "expert testimony out of court". The topics considered indicate the range and scope of the inquiry: organization of medical care; medical education; specialization; group practice; the place of the hospital; public health organization; experimentation; state medicine; health insurance; limited state medicine and private practice.

Naturally, from so wide a variety of contributors, unanimity or definitive conclusions are not to be expected. *Quot homines, tot sententiae.* Probably all these problems will ultimately be settled, as is the custom in human affairs, by the attrition of time and experience. Nevertheless, this carefully edited exposition remains a valuable record of contemporaneous opinion in the process of crystallization into decision.

Wetter und Jahreszeit in der Chirurgie (Effects of Weather and Season in Surgery). Georg Maurer. (Vorträge aus der praktischen Chirurgie, 20. Heft.) Stuttgart, Ferdinand Enke, 1938. 2.50 marks.

This monograph is not confined to surgical conditions, but gives a general survey of the relationship of meteorology to medicine, a relationship known to Hippocrates and appearing in statistical tables since 1770. It seeks explanation in the changes in tem-

DIE VITAMINE UND IHRE KLINISCHE ANWENDUNG. EIN KURZER LEITFADEN (V and their Clinical Application. A Short Guide). Dr. W. Stepp, Dr. J. K und Dr. H. Schroeder. 3 Aufl. Stuttgart, Ferdinand Enke, 1938. 9.50 m

This book attempts to review the present-day knowledge of the vitamins, wi chemical formulae and the physiological effects which they produce. The popul the work in German-speaking countries is attested by the appearance of the third unchanged six months after the appearance of the second. There is a fairly exh discussion upon the commonly known vitamins A, B, C, D, and E, with the subdi of vitamin B. A short discussion is given to vitamin H, apparently a protein, es to normal function of the skin and active in metabolism of fats and proteins. It sources are the liver and the kidneys of cattle and swine. It is present in small a in milk, potatoes, and bananas. The antihemorrhagic vitamin (factor T and vita is described. The absence of this vitamin or group of substances leads to a decr blood platelets. The T factor cannot be separated from fats and is associated wit min A. Vitamin K seems to be an oil soluble in alcohol, and to be present in mos tables, particularly cabbage and carrots. The permeability vitamin, vitamin P, i tioned briefly. It is usually associated with vitamin C and found when the less forms of vitamin C are given. Since many of the vitamins can be given in crys form, toxic effects from too large quantities are occasionally observed. A compl view of the world literature is given. The interrelationship of vitamin and m metabolism is discussed, but no conclusions are drawn. Many so-called vitamin act as enzymes or as catalyzers. While the work is incomplete, since the experimen and reporting of biological and chemical data concerning vitamins is progress rapidly, it is a sane, carefully weighed presentation of our present knowledge. It be of great value to students in this field, especially for its carefully selected bibliog

ATHLETIC INJURIES. PREVENTION, DIAGNOSIS AND TREATMENT. Augustus Thor Jr., M.D. Philadelphia, Lea & Febiger, 1938. $3.00.

This compact little volume represents the results of the observation of a well-t general surgeon at a large university, who has had a wide experience in handling matic injuries on the athletic field and through convalescence.

The history of the evolution of the methods at present employed at Harvard i outlined. The factors that enter into the attainment of physical fitness, as deter by those who have devoted themselves to research in these matters, have been take advantage of in respect to the skeletal muscular system, the cardiovascular and re tory systems, certain chemical and physical changes contributing to the efficiency trained athlete, and the central nervous system. Then follow three chapters on ph training, physical fatigue, and the prevention of injury. The remaining chapter with the injuries that befall the participants in the major sports and the treatm accorded them.

The text is well illustrated and furnishes the reader with a clear idea of wha been found to be best in the management of this kind of injury on the athletic field. book should be in the hands of all who are called upon to treat cases of this type.

WUNDVERSORGUNG UND WUNDBEHANDLUNG (The Care and Treatment of Wou Prof. Dr. Hans von Seemen. (Vorträge aus der praktischen Chirurgie, 19. I Stuttgart, Ferdinand Enke, 1938. 4.20 marks.

This is another monograph of a series which provides excellent lectures for stu or surgeon. Beginning with an outline of the history of and advances in the treatme wounds, it describes the pathological foundation for the distinction between healin primary and by secondary intention. The latter differs from primary healing quan tively, whereby the larger space and greater tissue reaction allow greater opportunit necrosis and infection. Operative incisions usually heal by primary intention; accid

A PRACTICAL GUIDE TO MASSAGE. C. Irene Carpenter. With introduction by David Katz, Ph.D. Baltimore, William Wood and Company, 1937. $2.00.

The author has in simple, non-medical language and in a conversational manner set down her method of approach to the application of massage as a therapeutic agent, mentioning also its allied modalities, active and passive movements, and some forms of electrical stimuli.

Part I is devoted to an elementary description of the anatomy and of the physiological and biological functions of the living body, and their relation to massage.

Presupposing on the part of the reader a working knowledge of massage, in Part II Miss Carpenter gives only a general description of the manipulations and their effects. The section on "Touch and Observation" is by far the most clearly expressed part of the entire book. The importance of this factor is well emphasized.

Part III, "Some Medical Conditions for which Massage and the Allied Treatments are Prescribed", is arranged, not according to pathology, but according to the views of the author as to similarity of treatment. The brief and generalized consideration both of pathology and of prescription makes the text vague and of questionable value. Far more skill and more knowledge are required in treating the various conditions than is suggested in the text—and in this the danger lies.

The book is not adequate for those who practise massage as a mechanical procedure only, and to the well-trained physiotherapist it offers little that is new.

ORTHOPÄDISCHE APPARATE UND BANDAGEN. AUS KLINIK UND WERKSTATT. (Orthopaedic Apparatus and Supports.) Prof. Dr. Georg Hohmann. 2 Aufl. Stuttgart, Ferdinand Enke, 1938. 6.80 marks.

In this monograph Prof. Hohmann, director of the Orthopaedic Clinic of the University at Frankfort, a.M., attempts a description of the various orthopaedic devices, used in the clinic and at work, for different disabilities of the spine and extremities. The apparatus for the most part will find its counterpart in similar types used in American clinics.

There is much that is commendable in this book, particularly the discussion on indications for the use of the various splints which are described, with advice for their continued adjustment so that they may function efficiently. However, one is left with the feeling that each part is considered mechanically as a unit, without due consideration of it as a portion of a dynamic whole, in the light of the kinesiology and statics of the body as a unit. From the description of deformities now rarely seen, one is made to feel that insufficient emphasis is placed upon the prevention of deformities. The illustrations are clear and well drawn. There is an excellent bibliography of pertinent German medical literature.

ALGUNOS ASPECTOS CLINICOS DE LAS HERIDAS POR ARMA DE FUEGO (Some Clinical Aspects of Gunshot Wounds). Prof. M. Bastos. Barcelona, Edit. Labor, 1936.

This book of about 150 pages and seventy-four illustrations, some of them in color, is a résumé of the practical experiences of the author in regard to war surgery. In six chapters he touches upon the general aspects of war wounds, gunshot fractures, septicaemia, bacteriology, and fundamentals of treatment. In the remainder of the book, the author considers gunshot fractures of the thigh, the leg, the foot, the arm, the forearm, and the hand. War injuries to the joints, the spine, the thorax, and the neck are also discussed.

Although small, this well-written and well-illustrated book will be helpful to every surgeon interested in war surgery.

VERHANDLUNGEN DER DEUTSCHEN ORTHOPÄDISCHEN GESELLSCHAFT. ZWEIUNDDREISSIGSTER KONGRESS. (Beilageheft der Zeitschrift für Orthopädie und ihre Grenzgebiete, LXVII.) Stuttgart, Ferdinand Enke, 1938. 26 marks.

Under the editorial guidance of Prof. Hohmann, this year's *Verhandlungen* records the Thirty-Second Congress of the German Orthopaedic Society, held in Rostock on

perature and barometric pressure resulting from the contacts of different air currents, whose conflicting movements produce changes in the earth's electromagnetic field and create forces of various wave lengths in the atmosphere. Such alterations in electrical conductivity are believed to be transmitted by the human skin and lungs to the parasympathetic nervous system. In some individuals, certain physiological responses may be almost barometric in their constancy, but the variability in human and atmospheric factors leaves the subject on a more statistical than scientific basis. Even now, however, there is sufficient evidence of this relationship to permit a degree of prophylaxis at times of sharp changes in barometric pressure and in temperature, particularly the avoidance of elective major surgery on such occasions. Maurer's monograph is informative and stimulating; it possesses a good bibliography; and it is of especial value in calling attention to the frequent coincidence of numerous diseases and afflictions and typical weather changes. The author understands the present limitations of his subject and urges its further investigation especially in the study of individual cases. He emphasizes not so much the effect of weather on disease as the effect of weather on both healthy and diseased individuals.

INFECTIOUS DISEASES OF BONES, JOINTS, AND CARTILAGES. Prof. V. D. Chaklin. Sverdlovsk, Sverdlovsk Regional Publication, 1937.

This book, embodying the personal experience of the author, is written for the practical surgeon. It reflects a much wider knowledge of the American and foreign literature than has been observed in previous books received from the U.S.S.R.

The author limits the scope of his book to the consideration of acute and chronic streptococcus, staphylococcus, typhoid, paratyphoid, typhus, and mycotic infections. Due place is given to pathology and physiology and this is well balanced by a detailed and clear description of treatment. The author emphasizes the importance of conservatism as well as of careful operative treatment. The orthopaedic management of residual deformities, as well as the simultaneous application of orthopaedic treatment and the treatment of the acute or chronic infection, is well presented. There is a good index of subjects and authors,—rather a novelty in the Russian medical literature. The book will undoubtedly be valuable for the Russian surgeon.

ORTHOPÄDIE UND KINDERLÄHMUNG. Dr. Friedrich Mommsen. Stuttgart, Ferdinand Enke, 1938. 3.85 marks.

This monograph upon the treatment of infantile paralysis is the result of thirty years of study and treatment of this disease at the *Oskar-Helene Heim* near Berlin. The monograph is dedicated to Konrad Biesalski with whom the author was associated until the death of Biesalski in 1930.

While there is little new in the book with the exception of ingenious but simple apparatus for the prevention of deformities, a broader point of view than is usually taken in this disease is frequently shown. The author stresses what he calls "sociobiological rehabilitation". By this he means that treatment and operative procedures are all planned with due consideration of the patient's capabilities and permanent physical handicap. The treatment should have as its aim not merely or always the purely orthopaedic treatment, but the fitting of the individual into that place in society which he can best fill. The methods of examination of muscle function are discussed, but no method of grading muscle strength is given. Exercise and active and passive redressement are discussed, but no statement is given as to when to use them and when not to use them. Early weight-bearing with apparatus is advocated, a procedure which is considered unwise in most American orthopaedic clinics. The indications and technique of tendon transplantations and arthrodeses are covered more adequately. Every operative procedure is considered, not as a local therapy, but in the light of the optimum balance of the body as a whole.

A Comparative Study of the Treatment of Oblique Fractures of the Shaft of the Tibia by Osteosynthesis, Osteotraction or only Reduction and Plaster. Oskar Lindén. *Acta Chirurgica Scandinavica*, LXXX, 365, 1938.

Follow-up examinations of some 250 cases of fracture of the shaft of the tibia furnish the material for 151 case summaries and the detailed tabulation of etiological data and end results. Errors from economic differences were minimal because all patients were from the same hospital and each method of treatment was used without selection of cases for a well-defined period of time (1908 to 1932). Internal fixation was by means of a screw in all but one case. Skeletal traction was used for from three to six weeks and then removed for the application of plaster in all but two cases in which the cast was applied immediately. Throughout the period simple immobilization in plaster with or without reduction was employed whenever possible, but only the cases since 1919 are included in this report.

The writer found that skeletal traction frequently allowed shortening and angulation. He characterized this form of treatment as troublesome and uncomfortable. Open reduction and fixation with a screw gave better end results and shorter healing periods. When done immediately, open reduction and internal fixation showed better results in oblique fractures than did closed reduction and the application of a cast, in spite of the fact that the latter form of treatment was used chiefly in the simpler cases. Among the cases operated upon, however, there was one case of tetanus, and one thigh amputation was necessary because of infection. It is stipulated that open reductions should be done only by experienced surgeons and under reliable aseptic conditions.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

On Infantile Coxitis and Its Sequelae. Soren Chr. Iversen. *Acta Orthopaedica Scandinavica*, VIII, 231, 1937.

Follow-up examinations of twenty-nine cases of infantile coxitis furnish the material for a critical review of the subject. The cases are arranged in three groups according to acute symptoms, and again into four according to late pathological changes. Early drainage and fixation are advocated in the acute stage, and a subtrochanteric osteotomy for the correction of the frequent late deformity. Case summaries are appended.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Late Results of Operation for Congenital Torticollis. Jens Foged. *Acta Orthopaedica Scandinavica*, VIII, 293, 1937.

Of 131 patients operated upon for congenital torticollis, 117 were subjected to follow-up examinations. A statistical review of these cases is furnished. Simple open myotomy at the distal end of the muscle was done in most cases and was followed by the application of a Schanz cotton collar. The internal jugular vein was injured twice. There were mild infections in three cases. End results were good in 86 per cent., fair in 11 per cent., and poor in 3 per cent. Other results are quoted from the literature.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Nachuntersuchungen von Patienten, behandelt wegen Spondylitis tuberculosa auf dem Seehospital bei Stavern 1911–1929 (End-Result Study of Patients Treated for Tuberculous Spondylitis at the Sea Hospital at Stavern, 1911–1929). Agnar Grevle. *Acta Orthopaedica Scandinavica*, VIII, 305, 1937.

Two hundred and thirty-seven cases of tuberculosis of the spine, in which 163 of the patients were under and seventy-four were over fifteen years of age, were investigated by questionnaire (10 per cent. by examination) in the interest of the statistical study which is submitted in detail. Spine fusion was performed only twice. Casts were applied in sixty-seven cases. Corsets were used in seventy-nine of the earlier cases,

Gaceta Peruana de Cirugía y Medicina (Lima), I, No. 2, 1938.
Medicine Today (Brooklyn, N. Y.), I, No. 3, 1938.
Radiography and Clinical Photography (Rochester, N. Y.), XIV, Nos. 2 and 3, 1938.
Revista de Cirugía del Hospital de Juárez (Mexico City), IX, No. 1, 1938.
Roche Review (Nutley, N. J.), II, Nos. 7, 8, and 9, 1938.
The Rotarian (Chicago), LII, No. 4, 1938.
University of Pennsylvania Bulletin. Graduate School of Medicine, Announcement for Session 1938–1939. Philadelphia, 1938.
Fractures and Dislocations. Volumes I and II. Philip Lewin, B.S., M.D. Edited by Morris Fishbein, M.D. New York, National Medical Book Co., Inc., 1937.

Über Olekranonfrakturen und deren Behandlungsresultate (Fractures of the Olecranon and the Results Following Treatment). E. Laukka. *Acta Chirurgica Scandinavica*, LXXIX, 93, 1936.

Of 103 patients with fracture of the olecranon, whose cases were studied, fifty-six returned for follow-up examination. Statistical data are recorded and the associated fractures are tabulated. Simple immobilization sufficed in the subaponeurotic type with separation of three millimeters. Bony union was obtained in 100 per cent., and good results in 90 per cent. When separation or comminution was present, semicerclage with wire was usually employed. With internal fixation, good results were obtained in 66 per cent.; a complete range of motion, in only 21 per cent.; and pseudarthrosis, in 18 per cent. Traumatic arthritis was present in 36 per cent. of the operated cases, but the functional result was good in half of these cases.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Intraärticular Malleolar Fractures. A Survey. ThoreWalheim. *Acta Chirurgica Scandinavica*, LXXIX, 166, 1936.

In 127 cases of intra-articular malleolar fractures, open reduction was performed in thirty-seven. Follow-up examinations showed the results to be better in the operated cases. Four and seven-tenths per cent. of the entire series of patients received disability compensation and 10 per cent. showed roentgenographic evidence of traumatic arthritis. The results in cases of fracture of the roof of the mortise were poorer than in those involving only the lateral supporting surfaces. End-result statistics are tabulated. These are compared with the results in 245 similar conservatively treated fractures from the Government Insurance Bureau in which the disability was more than twice as great. The writer suggests an extension of the indications for open operation. Skeletal traction was not used.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Über die Technik bei Inforatio Colli et Capitis Femoris ("Forage" nach Graber-Duvernay) [The Technique of Drilling the Head and Neck of the Femur]. Aage Berntsen. *Acta Chirurgica Scandinavica*, LXXX, 82, 1937.

In from 60 to 100 per cent. of the published cases of osteo-arthrosis of the hip joint in which the neck of the femur has been drilled, the pain has diminished. The procedure is indicated when there is unilateral involvement without excessive subcutaneous fat. The favorable outcome is attributed variously to changes in circulation; introduction of fresh granulation tissue and bone dust into the drill holes, thus contributing to new ossification; and alteration of the articular cartilage by the circulatory changes.

The technique is outlined for placing and withdrawing a screw with the aid of two sets of lead markers, a lead rule, and a level. The writer has treated twenty-nine patients in this manner, with diminution of the pain in all but two cases. In five cases there was recurrence of the pain.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

the apex of the curve and the line of pressure being directed obliquely in conformity with the position of the rib.

A design is suggested for the axillary crutch which would avoid undue pressure upon the anterior and posterior muscles of the chest. The author stresses the importance of a well-fitting rigid pelvic support, upon which the levering mechanism is dependent in the correction of the elements of the curve. He also emphasizes the futility of lifting the shoulder girdle in attempting to correct the thoracic deformity.—*Custis Lee Hall, M.D., Washington, D. C.*

AMBULATORY METHOD OF TREATING FEMORAL SHAFT FRACTURES, UTILIZING FRACTURE TABLE FOR REDUCTION. Roger Anderson. *American Journal of Surgery*, XXXIX, 538, March 1938.

This article embodies the continuation of the author's well-known method of pin fixation and reduction of fractures of the femur, using two pins above and two below. He stresses the importance of spiral fractures causing difficulty due to locking of the fragments, and that overtraction is often necessary to obtain proper reduction.

A series of cases is reported which shows excellent reduction of subtrochanteric and supracondylar fractures. The advantage claimed by the method is better control of the fragments and more rapid and secure reduction which, when properly done can be maintained by the incorporation of the upper and lower pins in a well-fitting plaster cast. Two pins are used below to prevent lateral slipping of the lower fragment. The method is claimed to give much more rapid rehabilitation, less hospitalization, freedom of hip and knee movements, minimum of aftercare and thorough maintenance of fragments in correct position.—*Custis Lee Hall, M.D., Washington, D. C.*

ROENTGENOGRAPHIC FEATURES OF TUBERCULOSIS IN BONES AND JOINTS. Charles G. Sutherland and Ercell A. Addington. *American Review of Tuberculosis*, XXXVII, 31, Jan. 1938.

Tuberculosis of bone is a metastatic process. An embolism of bacilli is carried to the region by the blood stream and deposited either in synovia or in marrow. The outstanding roentgenographic characteristic is the translucency of the bone shadow without evidence of proliferation of bone. Regional bone atrophy and loss of the bony articular surface in non-contacting areas, with preservation of the bony articular cortex in contacting areas, occur early. Sequestra are rare. These changes appear as rarefaction with little evidence of reaction of tissues and clouding of the joint.—*M. Rosenbaum, M.D., Iowa City, Iowa.*

FRACTURAS SUPRACONDILEAS INFANTILES (Supracondylar Fractures in Children). F. Jimeno Vidal. *Anales del Servicio de Traumatología, Cirugía Ortopédica y Accidentes del Trabajo del Hospital Provincial de Valencia*, Febrero 1936.

The great osteogenetic capacity of the infantile periosteum and its tendency to bone proliferation when it is irritated are the chief reasons for the use of gentle manipulations, the postponement of any kind of surgical operation, and the establishment of after-treatment on the lines of uninterrupted rest until bony union takes place. The author warns against removing the splint every two days in order to see "how things are going on", moving the joint, or employing any form of massage.

The fracture is reduced under a local anaesthetic (20 cubic centimeters of a 2-per-cent. novocain solution). The patient is placed on a table, and the surgeon exerts traction, pulling the forearm flexed at a right angle. Countertraction through a sling, or obtained by placing the surgeon's knee on the patient's axilla, is effective. This causes the shortening to disappear. Digital pressure reduces the forward position of the proximal fragment. The forearm should be held in forced pronation to counteract the varus position and to prevent radial palsy. Fixation is by means of a non-padded plaster-of-Paris splint.—*Francisco P. Dueño, M.D., Madrid, Spain.*

and twenty-one of the patients continued to get worse. In sixty-seven of the later cases plaster beds and no corsets were used, and seven of the patients became worse. The figures are not comparable in evaluating the methods of support, however. In all, about half of the patients remained well. Thirty-nine died while under treatment (five from non-tuberculous causes); forty-seven died after leaving the hospital (three from non-tuberculous causes).—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

FURTHER EXPERIENCE IN THE DIAGNOSIS OF HYPERPARATHYROIDISM, INCLUDING A DISCUSSION OF CASES WITH A MINIMAL DEGREE OF HYPERPARATHYROIDISM. Fuller Albright, Hirsh W. Sulkowitch, and Esther Bloomberg. *American Journal of Medical Sciences*, CXCIII, 800, 1937.

This report is based on thirty-five cases of hyperparathyroidism, proved by operation, studied at the Massachusetts General Hospital over a ten-year period. The authors bring out the fact that cases are sent to them which are not being recognized at other clinics. These cases include: (1) those with no demonstrable bone disease (twelve cases); and (2) those with a very moderate degree of hyperparathyroidism (eight cases). The presence or absence of bone disease is not an indication of the degree of hyperparathyroidism,—some of the severe cases did not have it and some of the mild ones did have it. In patients with bone disease and high serum-phosphatase levels, as a rule, postoperative hypocalcaemia develops; it seldom occurs in other cases.—*M. Mendelsohn, M.D., Iowa City, Iowa.*

THE TREATMENT OF ACUTE INFECTIOUS ARTHRITIS OF UNDETERMINED ORIGIN WITH ARTIFICIAL FEVER. Robert M. Stecher and Walter M. Solomon. *American Journal of Medical Sciences*, CXCIV, 485, 1937.

Acute non-specific infectious arthritis is a relatively common syndrome which has received scant attention in the literature and may be regarded as an acute form of atrophic, rheumatoid, or chronic infectious arthritis.

Of twenty patients, ranging in age from fourteen to fifty-one years, treated with artificial-fever therapy, twelve (60 per cent.) received prompt relief and apparent cure, while eight (40 per cent.) were partially relieved. The course of the disease was favorably modified in every case. These results compare favorably with those observed in the treatment of acute gonorrhoeal arthritis with artificial fever.

Treatment consisted in induced fever (about 105 degrees Fahrenheit) by means of the Kettering hypertherm, maintained usually for four or five hours. The patients who recovered completely received this treatment for from two to twenty-five hours, averaging seven and three-tenths hours.

Increased circulation, with an increase in phagocytosis, occurs, but the complete mechanism which produces benefit is not fully known.

Herpes labialis has been found to occur as a complication of this form of therapy in one-third of the cases after the first treatment only.—*M. Mendelsohn, M.D., Iowa City, Iowa.*

SOME THEORETICAL CONSIDERATIONS IN THE CONSTRUCTION OF ACTIVE SCOLIOSIS BRACES. Josef Wolf. *American Journal of Surgery*, XXXIX, 557, March 1938.

The author reviews the literature in regard to the types of so-called active scoliosis braces, referring especially to apparatus worn during the day, with attempt to correct the deformity by mechanical means. He divides the components of the curve into: (1) curvature of the spine itself; (2) overhang on one side of the pelvis; (3) torsion and hump formation; (4) diminution of the height of the body.

The difficulty of bringing mechanical forces to play upon the spine itself is reviewed. This can only be done effectively through the ribs, with the correcting force applied below

examination were negative. There was no deformity of either arm and no shortening of the right arm, in spite of the marked involvement. All joints in the body had a normal range of motion. The legs were somewhat deformed, as already described, but there was no inequality in leg length.

The laboratory data were as follows:

Red blood cells—4,100,000

Hemoglobin—90 per cent.

White blood cells—5,200

Polymorphonuclear leukocytes—67 per cent.

There were no pathological cells. The Kahn test and urinalysis were negative. The tuberculin test—human and bovine, 1:1000—was positive. The basal metabolic rate was minus 4 per cent.

The roentgenograms showed the changes characteristic of this condition,—the longitudinal striation affecting the ends of the diaphyses of almost all the long bones in the three involved extremities, the cross striations, the gouged-out appearance in places, the irregular spotted areas of secondary calcium deposit (especially in some of these apparently gouged-out places), and numerous spherical areas having the appearance of bone cysts as seen in osteitis fibrosa cystica. There was also noted the fan-shaped striation in the wings of the ilia, as described by Bentzon and others.

Characteristically, there was no involvement of the carpal or tarsal bones. Multiple enchondromata of the long bones of the hands and feet, frequently present in these cases, were evident only in mild degree in a few areas, and these lesions seemed to show a high degree of development according to our series of roentgenograms.

Because of the recent tendency to remove parathyroid glands in generalized bone conditions characterized by cyst formation and deformity, it seemed important to make observations on the calcium and phosphorus metabolism. These observations were carried out according to the method of Bauer and Aub.

The patient was placed on a low-calcium diet from September 26 to 29, 1935. Analyses during this time are compiled in Table I.

The levels of calcium, phosphorus, and phosphatase in the blood were within the limits seen in children of this age. There was a negative balance of calcium, although much less than that of the normal adult. A minimal amount of calcium was excreted by the kidneys, the loss being preponderantly by way of the bowel.

In this case the shortening and expansion of the ends of the long bones, described in many of these cases, were not present, but probably the process has not yet progressed to that stage of the disease. It is also possible that the deformities have been somewhat minimized by protection

TABLE I

METABOLISM STUDY OVER A THREE-DAY PERIOD

| | Stool | Urine | Total Output | Intake | Balance | Blood |
|---|---|---|---|---|---|---|
| Calcium | 0.4400 | 0.0104 | 0.4504 | 0.1875 | −0.2629 | 10.8<br>10.9 |
| Phosphorus | 0.7400 | 1.0780 | 1.8180 | 1.2840 | −0.5340 | 4.72<br>4.85 |
| Phosphatase | | | | | | 11.0<br>11.5 |

UN NUEVO MÉTODO DE TRATAMIENTO DE LAS FRACTURAS DEL CUELLO DEL FÉMUR (A New Method for the Treatment of Fractures of the Neck of the Femur). E. T. López-Trigo. *Anales del Servicio de Traumatología, Cirugía Ortopédica y Accidentes del Trabajo del Hospital Provincial de Valencia,* Mayo 1936.

Since the usual method of treating intertrochanteric fractures—keeping the patient in bed for two or three months—is not safe in treating elderly patients, the author presents a method which reduces the time in bed without impairing the reduction and consolidation of the fracture.

After taking two roentgenograms and putting the leg in a Braun splint, the author inserts a Kirschner wire through the femoral condyles and attaches a fifteen-kilogram weight. Traction is maintained until the coxa-vara position is changed into a position of forced coxa valga. When the changed position is apparent roentgenographically, without removing the weight, the author applies a plaster-of-Paris spica. The wire is then removed, and a zinc-glue bandage applied to the leg and foot enables the patient to walk. This bandage is worn for three months. Sixty-three patients have been treated by this method with satisfactory results.—*Francisco P. Dueño, M.D., Madrid, Spain.*

FRACTURAS ABIERTAS DIAFISARIAS (Compound Fractures of the Shaft). E. T. López-Trigo. *Anales del Servicio de Traumatología, Cirugía Ortopédica y Accidentes del Trabajo del Hospital Provincial de Valencia,* Julio–Diciembre 1936.

During the past five years the author has had under his care 448 cases of compound fracture of the shaft in civilians. Of these, 398 were operated on within five hours after injury; in the other fifty cases the operation was not performed until this time had elapsed. In the first group, there were only ten cases of severe infection of the gangrenous type and no deaths; in the second group, gangrenous infection resulted in sixteen cases; amputation, in six; and death, in four.

Over the same period the author also treated 142 cases of gun-shot fractures of the shaft. In this series five gangrenous infections and eight severe non-gangrenous infections developed, and there were three amputations and two deaths.

The author recommends primary suture, after mechanical cleansing of the wound, during the first five hours following the injury; fixation of the fragments in plaster or the insertion of a Kirschner wire. The successful outcome of these cases depends on perfect immobilization. When primary suture is impossible, the author recommends vaselin-gauze packing and plaster-of-Paris cast.—*Francisco P. Dueño, M.D., Madrid, Spain.*

GIANT CELL TUMOR OF THE CERVICAL SPINE. DeForest P. Willard and Jesse Thompson Nicholson. *Annals of Surgery,* CVII, 298, Feb. 1938.

Giant-cell tumor of the cervical spine is a comparatively rare lesion. The authors estimate that the lesion occurs in the vertebrae in about 8 per cent. of the cases. The cervical vertebrae are reported involved in seven instances.

A decided majority of all giant-cell tumors occur in individuals over twenty years of age, but the majority of vertebral lesions are found in individuals under twenty years of age.

Giant-cell tumor is classified as non-malignant, but Coley and Meyerding reported the cases of patients who died of metastases. Geschickter and Copeland recognize a "malignant variant which is the result and not the cause of recurrence". They also claim that the "malignant variant" structure is primary and, if recurrence results, metastasis is apt to follow. One would infer from this that inadequate removal is responsible for secondary changes in the tumor.

The authors conclude that the treatment of choice is curettement; if this fails resection or amputation must be performed.

The case reported by the authors was that of a white female, aged nine. When the

child was first examined, it was believed that there was a forward dislocation of the right inferior facet of the third cervical vertebra. She was treated in hyperextension for two weeks without any results and then a Walton manipulation was done, followed by application of a plaster cast to the head and the torso. Several weeks later when the cast was removed, roentgenographic examination revealed the presence of a rounded cystic tumor, projecting posteriorly from the fourth cervical vertebra. The tumor was completely removed by laminectomy. Pathologically, it resembled the spindle-cell variant of giant-cell tumor recognized by Geschickter and Copeland. One year after removal the patient was free from symptoms and roentgenographic examination did not show any recurrence.—*O. B. Bolibaugh, M.D., San Francisco, California.*

TREATMENT OF FRACTURES OF THE SHAFT OF THE FEMUR. AN ANALYSIS OF ONE HUNDRED AND TWENTY CASES. Robert H. Kennedy. *Annals of Surgery*, CVII, 419, Mar. 1938.

The author analyzed 120 consecutive cases of recent fractures of the shaft of the femur treated by the Staff of the Beekman Street Hospital from January 1924 to March 1932. These patients were treated by some ten different surgeons, but each case had the advantage of General Staff discussions of the details of the treatment.

Patients were classified according to the location of the fracture and according to age.

There were seventeen early deaths in the series, including one patient who died after amputation was performed. There were two other patients requiring amputations. This leaves one hundred and one patients for detailed analysis of treatment. Fourteen of the early deaths occurred in patients with severe multiple injuries.

Forty-eight of the patients analyzed were under sixteen years of age. Forty-seven had fractures resulting from automobile accidents. There were but four compound fractures and twenty comminuted fractures in the series.

The primary hospital treatment in forty-three cases was adhesive-plaster traction with suspension in a Thomas splint; skeletal traction was used in thirty-five cases; overhead adhesive-plaster traction in eleven cases; reduction and application of a plaster spica in eleven cases, and open reduction in one case.

The final treatment, except where complications occurred, was skeletal traction in forty-three cases; adhesive-plaster traction with suspension in a Thomas splint in thirty-one cases; reduction and application of a plaster spica in twelve cases; overhead adhesive-plaster traction in eleven cases, and open reduction in four cases.

The initial treatment was unsatisfactory in fourteen cases of adhesive-plaster traction with suspension and in two cases treated by reduction and application of plaster spica.

Traction methods were employed in treating 87 per cent. of these patients. The author prefers the Kirschner wire to tongs and Steinmann pins which were used in the earlier cases.

There were four open reductions, all in children. In three cases there were simple fractures and one was compound. In the compound-fracture case infection developed, followed by osteomyelitis, but solid union occurred.

Three patients required late open reductions for complications. Four patients sustained refractures.

In eighty-four patients solid bony union was known to have developed and in one non-union developed.

The author concludes that by traction methods bony union with relatively little shortening and good functional results may be obtained in a high percentage of cases. He does not feel that the results obtained in this series were good enough. Overhead adhesive traction was satisfactory in children under five years of age. Skin traction was unsatisfactory in children over five years of age from the point of view of recovering original length. Skeletal traction in adults gave too high an incidence of infection. He condemns closed reduction and application of a plaster spica.

In March 1932 the surgeons changed to Russell traction in all of these groups. They are still not satisfied with their results and believe that they should perform more open reductions with internal fixation especially in transverse fractures of the middle and lower thirds of the femur.

Skeletal traction has been a marked improvement over reduction and application of a plaster spica or adhesive-plaster traction with suspension in a Thomas splint. No single method is applicable to all cases and one should be ready to use each type of treatment according to the individual indications.—*O. B. Bolibaugh, M.D., San Francisco, California.*

INJURIES ABOUT THE SHOULDER JOINT IN CHILDREN, EXCLUSIVE OF FRACTURES OF THE CLAVICLE. John E. Sullivan. *Annals of Surgery*, CVII, 594, Apr. 1938.

The author made a study of the records of sixty-one children under twelve years of age, with injuries about the shoulder joint, exclusive of fractures of the clavicle, who had been admitted to the Children's Surgical Service of Bellevue Hospital during the past ten years.

Fifty-five of these patients had fractures of the upper end of the humerus, four had fractures of the scapula, one had a subluxation of the head of the humerus, and one had an acromioclavicular separation. There were no instances of separation of the upper humeral epiphysis or of apparent injury to this epiphysis.

Most of the fractures were produced by a fall, and the author describes in detail the mechanics of the injury.

Various methods of treatment did not give anatomical reductions but functional results were excellent and in many instances complete anatomical readjustment occurred in a few months.

There were three pathological fractures of the upper end of the humerus in the series. Fractures occurred more often in the left than in the right humerus. There were three cases of fracture of the body of the scapula which were all caused by severe trauma.

The methods of treatment used were manipulations under anaesthesia or traction.—*O. B. Bolibaugh, M.D., San Francisco, California.*

ÄTIOLOGIE- UND SCHMERZPROBLEME BEI DER GENUINEN ARTHROSIS DEFORMANS. (KLINISCHE UND TIEREXPERIMENTELLE UNTERSUCHUNGEN ÜBER DIE PHYSIOPATHOLOGIE DER GELENKKAPSEL.) [Etiology and Production of Pain in True Arthritis Deformans.] H. R. Paas. *Archiv für klinische Chirurgie*, CLXXXVIII, 1, 1937.

In a consideration of the etiology and pathology of idiopathic arthritis deformans—also known as degenerative or hypertrophic arthritis—one is impressed by the concerted teaching of the past that the primary pathological changes are in the articular cartilage. The capsular changes and their importance are entirely overlooked.

The author presents convincing evidence that the synovial membrane and capsule are the seat of very early pathological changes as a result of a deficient vascularization. This poor circulation of the capsular apparatus is responsible for an altered permeability of the synovial membrane and a disturbed production of the synovial fluid. The author presents experimental data which show that the absorption time of contrast fluids injected in joints was regularly increased with advancing age of the animals. With the decreased permeability is associated an increased intra-articular pressure. The decreased permeability and increased intra-articular tension are due to a decreased elasticity of the synovial membrane and the connective tissue therein. The capsule shrinks, and the absorbing joint surface becomes greatly reduced.

Subjective complaints vary directly with these pathological phenomena. The latter account for the frequent presence of severe subjective symptoms in a joint which shows very little or no objective deformity in the roentgenogram.

In the treatment of these joints, therapy must be directed to increase the circulation of the involved tissues. The author recommends intra-articular injections of substances

that produce a prolonged hyperaemia in the periarticular tissues, resulting in an increased production of synovial fluid, stretching of the capsule, and diminution of pain. For this purpose, the author employs a high molecular fatty acid ester called "immetal" and obtains very gratifying results.—*Harold Unger, M.D., Iowa City, Iowa.*

PATHOLOGISCHE ANATOMIE DER MENISCUSSCHÄDEN (Pathology of Meniscus Lesions). W. Ceelen. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVII, 334, 1937.

The author studied two series of semilunar cartilages: (1) 200 post-mortem specimens; (2) 270 surgical specimens.

In the first group he found degenerative processes in 40 per cent. This susceptibility to degeneration is explained as being due to poor blood supply. Blood vessels enter the cartilage at its marginal aspect and at the cornua, supplying about one-third of the width of the cartilage. The remaining two-thirds has neither blood nor lymph vessels. Nutrition is supposed to take place from the synovial fluid by diffusion. The author found hyaline thrombosis of meniscus vessels in a case of endocarditis lenta and septicaemia, and a purulent meniscitis with total breakdown of the cartilage in another case of pyaemia. In cases of chronic nephritis and arteriosclerosis he found exhaustive degeneration with spontaneous liberation of menisci.

In the second group the author found that healing of small tears takes place by scar formation and that the larger tears heal by organization of the lacerated edges or by a partial regeneration if the capsule connection is intact.—*D. H. Bruns, M.D., Iowa City, Iowa.*

OBJEKTIVE UNTERSUCHUNGSMETHODE ZUR FESTSTELLUNG DER BEWEGUNGSMÖGLICHKEIT DER WIRBELSÄULE (Objective Methods of Examination to Demonstrate Vertebral Mobility). Rostock. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVIII, 263, 1937.

The author reenforces visual examination of spinal mobility by examination of lateral roentgenograms of the thoracolumbar and lumbosacral spine in maximal flexion and maximal extension. If the sacra are superimposed, the levels at which abnormal mobility is present may be analyzed. In controversial cases, the method has proved of value.—*J. E. Milgram, M.D., New York, N. Y.*

DIE BEWEGUNGSBEHANDLUNG DER KNIEGELENKEITERUNG NACH WILLEMS UND IHRE ERFOLGE (The Willems Treatment of Knee-Joint Suppuration by Active Motion and Its Results). Hohlweg. *Archiv für Orthopädische und Unfall-Chirurgie*, XXXVIII, 268, 1937.

The author advocates the use of the Willems method of active motion after parapatellar incisions have been used to drain the knee joint. The incisions curve back somewhat, are adequate to expose the recesses of the joint, and avoid division of the lateral ligaments or essential extensor apparatus of the knee. The synovia is stitched to the skin. A wire through the os calcis and suspension of the limb make it easier to obtain motion early. The author finds the pain has not been as severe as reported. He resorts to x-ray radiation of the knee and transfusions as useful adjuncts.

Since January 1935, nine cases have been adequately followed, and good mobility of the knees has resulted in seven.—*J. E. Milgram, M.D., New York, N. Y.*

SHORT WAVE DIATHERMY IN SUBDELTOID BURSITIS. Louis Feldman. *Archives of Physical Therapy*, XVIII, 411, 1937.

The author has drawn his conclusions from 100 cases of subdeltoid bursitis in which some degree of calcification was present. The technique was as follows: twenty-four-

In March 1932 the surgeons changed to Russell traction in all of these groups. They are still not satisfied with their results and believe that they should perform more open reductions with internal fixation especially in transverse fractures of the middle and lower thirds of the femur.

Skeletal traction has been a marked improvement over reduction and application of a plaster spica or adhesive-plaster traction with suspension in a Thomas splint. No single method is applicable to all cases and one should be ready to use each type of treatment according to the individual indications.—*O. B. Bolibaugh, M.D., San Francisco, California.*

INJURIES ABOUT THE SHOULDER JOINT IN CHILDREN, EXCLUSIVE OF FRACTURES OF THE CLAVICLE. John E. Sullivan. *Annals of Surgery*, CVII, 594, Apr. 1938.

The author made a study of the records of sixty-one children under twelve years of age, with injuries about the shoulder joint, exclusive of fractures of the clavicle, who had been admitted to the Children's Surgical Service of Bellevue Hospital during the past ten years.

Fifty-five of these patients had fractures of the upper end of the humerus, four had fractures of the scapula, one had a subluxation of the head of the humerus, and one had an acromioclavicular separation. There were no instances of separation of the upper humeral epiphysis or of apparent injury to this epiphysis.

Most of the fractures were produced by a fall, and the author describes in detail the mechanics of the injury.

Various methods of treatment did not give anatomical reductions but functional results were excellent and in many instances complete anatomical readjustment occurred in a few months.

There were three pathological fractures of the upper end of the humerus in the series. Fractures occurred more often in the left than in the right humerus. There were three cases of fracture of the body of the scapula which were all caused by severe trauma.

The methods of treatment used were manipulations under anaesthesia or traction.—*O. B. Bolibaugh, M.D., San Francisco, California.*

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meter short-wave diathermy was used for treatments composed of exposures to from 700 to 1,500 milliamperes for twenty minutes every day for one week, then every two days for one week, and then biweekly for from two to four weeks or until symptoms disappeared. The results show relief of pain by three to six treatments and return of function by ten to twelve treatments. The author recommends this therapy in all cases of subdeltoid bursitis. The only contra-indication is a purulent bursitis.—*J. B. Davis, M.D., Iowa City, Iowa.*

SPINE FUSION IN TUBERCULOUS SPONDYLITIS. A. Strasser. *Archivio di Medicina e Chirurgia*, Febbraio 1937.

The author feels that the conservative views of Calot and Galeazzi in dealing with tuberculosis of the spine have lost a great deal of weight in view of the many splendid results obtained by operation. He believes that surgery is not indicated in tuberculosis of the cervical spine. He also points out that fusion between the bodies of the vertebrae and the laminae does not occur before the sixth year, and he does not operate on children under six years of age. Furthermore, tuberculosis of the spine in children has a better outlook without surgery than in adults, and, as the economic factor is not so important, the author usually prefers to wait until the patients have attained the age of sixteen before he does fusion operations. However, he favors the operative treatment in adults and feels that the possibility of giving those patients many years of useful existence is reason for attempting an operation which is not dangerous.

Of sixty-eight patients followed over one year, the author reports cure in 81 per cent., improvement in 13 per cent., no improvement in 4.5 per cent., and death in 1.5 per cent.

The author favors the use of local anaesthesia exclusively, and he operates through a window in a body jacket. He tries to get his patients on their feet in thirty days. One-half of his patients were ambulatory at the end of this period, and no ill effects were noted.—*A. W. Ciani, M.D., Iowa City, Iowa.*

SULLE FRATTURE ISOLATE CONDILOIDEE E DIACONDILOIDEE DELL'ESTREMO INFERIORE DELL'OMERO E LORO ESITI (Isolated Condylar and Diacondylar Fractures of the Lower End of the Humerus). Luigi Racugno. *Archivio di Ortopedia*, LIII, 255, 1937.

Fracture of the external condyle of the humerus was found to be the most frequent fracture of the lower end of the humerus, occurring in 38 per cent. of fifty cases. Isolated fracture of the internal condyle was present in two cases, fracture of the eminentia capitata and diacondylar fractures were represented by one case each. The mechanism, clinical and roentgenographic symptomatology, and treatment are discussed.

In eight cases with incomplete fracture or complete fracture with little displacement, good consolidation with complete use of the arm was obtained without any growth disturbance even several years after trauma. In only one case did cubitus valgus occur. In four cases of fracture of the outer condyle with displacement and rotation of the fragment around its own axis, open reduction with fixation of the fragment was performed to prevent pseudarthrosis, cubitus valgus, and limitation of motion. The late results were excellent in both anatomical and functional respects. Surgical removal of the external condyle was performed in five old cases in which there was malunion. The functional result was excellent two to three years after the operation, but there was a moderate degree of cubitus valgus. The author feels that fracture of the eminentia capitata is best treated by closed reduction. One case of isolated fracture of the inner condyle without displacement was treated with simple immobilization in a bandage of plaster-of-Paris for three weeks; the result was good. In another case with more displacement an open operation was performed and the fragment was replaced and screwed on; the result was also satisfactory.—*Ernst Freund, M.D., Los Angeles, California.*

NUOVI CRITERI DIRETTIVI DELLE OSTEOTOMIE SOTTOTROCANTERICHE NELLE LUSSAZIONI INVETERATE DELL'ANCA (New Indications for Subtrochanteric Osteotomy in Congenital Dislocation of the Hip Joint). A. Albanese. *Archivio di Ortopedia*, LIII, 347, 1937.

After a historical review of the development of subtrochanteric osteotomy from the corrective procedure of Kirmisson to the bifurcation operation of Lorenz, the author discusses critically all the advantages and disadvantages of the different procedures and especially the importance of the mechanical support of the pelvis by the proximal fragment. Since 1933, Albanese has used a Z-shaped subtrochanteric osteotomy which presents several advantages,—namely, it keeps the fragments in better contact; the proximal fragment is placed in adduction, thus tightening the abductor muscles; it further permits lengthening of the extremity; there is no danger of pseudarthrosis or ankylosis of the hip joint. The author reports several cases in which the procedure has been carried out with success.—*Ernst Freund, M.D., Los Angeles, California.*

LA PERIARTRITE CALCAREA DEL GOMITO (Periarticular Calcification of the Elbow). Aldo Fiorentini. *Archivio di Ortopedia*, LIII, 385, 1937.

The author has observed four cases of an elbow lesion which clinically has great resemblance to tennis elbow, but roentgenologically and histologically the cases belong to the group of periarticular calcifications. In none of the cases was there a history of trauma. In only one case was surgical intervention necessary. In the other three cases roentgenotherapy was instituted,—two patients were completely cured and the calcification disappeared; the third patient improved under roentgenotherapy, but symptoms recurred. The specimen removed from the patient who was treated surgically showed that the calcification was within the tendon tissue of the common extensor muscle.—*Ernst Freund, M.D., Los Angeles, California.*

SUL TRATTAMENTO DELLE FRATTURE MAL CONSOLIDATE, DELL'ESTREMO INFERIORE DELL OMERO (On the Treatment of Malunion of the Lower End of the Humerus). A. Albanese. *Archivio di Ortopedia*, LIII, 417, 1937.

In the treatment of malunion of the lower end of the humerus several important factors must be taken into consideration, which the author lists as follows:

1. Joint stiffness, which is considered mainly as a defense mechanism to prevent pain. In such cases physical therapy should not be forced. The joint should be immobilized in the early stages; later, motion should alternate with rest periods.

2. Post-traumatic para-articular ossification. The best prophylaxis for traumatic myositis ossificans is early and accurate reduction followed by immobilization. If, despite every precaution, there is the imminent danger of para-articular ossification, x-ray therapy should be tried. It gives good results in the early and recurring stages of ossification. More extensive ossifications with bone-block formation require surgery.

3. Limitation of joint motion by displacement of the fragments in the sagittal plane. In Kocher's extension fractures, the distal end of the shaft lies in front of the epiphysis and interferes with flexion. Treatment consists in surgical removal of the prominent portion of the diaphysis. Albanese has operated in a few cases, doing a resection of the lower end of the diaphysis and a curved osteotomy to prevent too extensive areas of roughened bone. In flexion fractures with displacement of the epiphysis forward, a hinge osteotomy is performed in the sagittal plane. In more severe cases, a wedge osteotomy has to be resorted to, with a posterior base, through a lateral or posterior incision.

4. Displacements in the frontal plane. In cases of valgus deformity of the elbow, reduction and fixation by periosteal stitches are advocated for fracture of the outer condyle, occasionally with temporary osteosynthesis by foreign material. Where there is varus deformity of the elbow, a hinge osteotomy in the frontal plane through a lateral or posterior incision is recommended, or a hemiwedge osteotomy with base outward.—*Ernst Freund, M.D., Los Angeles, California.*

LE COSIDDETTE "EPIFISI MARGINALI" O PUNTI COMPLEMENTARI TARDIVI D'OSSIFICAZIONE DELLE PARTI LATERALI DELL'OSSO SACRO (The so-called Marginal Epiphysis or Accessory Points of Ossification of the Lateral Portions of the Sacrum). Gioffredo Giraudi. *Archivio di Ortopedia*, LIII, 481, 1937.

The author calls attention to the accessory epiphyses of the marginal portions of the sacrum. They are known and described in the textbooks, but Giraudi believes that the textbook descriptions do not conform to the actual findings. He gives as an example the schematic picture of Testut, which shows the bony development in the sacrum and the appearance of two marginal epiphyses, one extending along the auricular surface of the sacrum and comprising the upper two segments, and the other extending over the lower part of the sacrum and comprising the remaining three segments. Giraudi found these marginal epiphyses quite frequently, but only belonging to the upper sacral segments. Occasionally the epiphysis extends, wedge-like, into the space between the first and second sacral segments. These marginal epiphyses are usually found together with a bony nucleus in the posterior superior iliac spine, one extending along the iliac crest and another from the sciatic tuberosity along the inferior margin of the ascending branch of the ischium. These epiphyses may have some practical importance because a tuberculous process may have its origin in an accessory epiphysis.—*Ernst Freund, M.D., Los Angeles, California.*

A PROPOSITO DELL'IMPIEGO DEI RAGGI ROENTGEN NEL TRATTAMENTO DELL'EPICONDILITE (Concerning the Use of X-Ray in the Treatment of Tennis Elbow). A. Mastromarino. *Archivio di Ortopedia,* LIII, 497, 1937.

The question whether x-ray or surgical treatment is preferable in cases of epicondylitis of the humerus is still under discussion. The author is very much in favor of surgery, but he does not deny that occasionally x-ray treatment is efficient and almost always frees the patient from pain. Chronic cases, however, with inflammatory and anatomical lesions of the common extensor of the fingers, should be treated surgically because x-ray treatment gives only temporary relief.—*Ernst Freund, M.D., Los Angeles, California.*

ANZEIGSTELLUNG UND TECHNIK DER LUNATUMEXSTIRPATION (Indication and Technique of Lunate Extirpation). Walter Nell. *Bruns' Beiträge zur klinischen Chirurgie,* CLXV, 619, 1937.

In general, dislocated lunate bones should be reduced if at all possible. Open reduction is possible three, four, or even six weeks after displacement. Böhler, using mechanical distraction at open operation, in one case reduced a dislocation of six months' duration. As a rule, end results are good in these reduced dislocations of the lunate.

Fractures of the lunate rarely form pseudarthroses as do fractures of the navicular, and operative excision is indicated only rarely in comminuted fractures. Long fixation may be required in fracture of the lunate.

Extirpation is reserved for cases of lunate malacia which have been treated for at least six months by rest, without success. If arthritis deformans is visible roentgenographically, it is too late (in the opinion of Polchau) to operate, since neither function nor pain will be improved.

To spare the remaining important wrist ligaments, the author advocates the palmar incision. The dorsal incision, while easier, injures many ligaments, which later results in serious carpal disturbances. It is difficult to avoid traumatizing the adjacent joint cartilages through a dorsal incision, since extensive stripping is required. A curved tenotome helps to free the bone at operation, dividing only the ligaments which insert on the lunate. A longitudinal incision, from five to six centimeters in length, is used, commencing one centimeter above the pisiform. The median nerve and finger flexors are retracted ulnaward.—*J. E. Milgram, M.D., New York, N. Y.*

DIE MENISKUSVERLETZUNG UND IHRE BEHANDLUNG (Injury to the Meniscus and Its Treatment). Walter Jehn. *Bruns' Beiträge zur klinischen Chirurgie*, CLXVI, 278, 1937.

The author reports eighty-three cases of injury to the meniscus. In establishing the diagnosis the following signs are of importance: (1) the spontaneous appearance of a cartilage in the joint space; (2) locking; (3) recurring effusion; (4) circumscribed pressure and spontaneous pain on bending or stretching of the knee. If, after three weeks of conservative therapy, locking, circumscribed pain with muscle weakness, and effusion persist, an operation should be performed. If operation is delayed too long, arthritis deformans develops. The operation consists of an S-shaped incision in the meniscus. The synovia is not sutured in order to permit drainage of the effusion into the periarticular tissue. The fascia only is sutured. No compression bandage is used. Active movements are allowed at the end of ten days and passive movements after fourteen days.—*Ernst Bettmann, M.D., New York, N. Y.*

DIE VENTRALE WIRBELKANTENFRAKTUR (RANDLEISTENABSPRENGUNG) UND IHRE BEZIEHUNGEN ZUR ADOLESZENTENKYPHOSE. [Anterior Fracture of the Margin of the Vertebra (Fracture of the Epiphysis) and Its Relation to Adolescent Kyphosis.] Walter Hetzar. *Bruns' Beiträge zur klinischen Chirurgie*, CLXVI, 345, 1937.

The author reports seven cases of fracture of the so-called vertebral epiphysis (*Randleiste*). He states that the pathology is due not to trauma alone, but to a combination of trauma with adolescent kyphosis. The latter causes the vertebral margins to have a tendency to separate, and, when trauma is added, the fracture occurs. The fracture line always lies in the vicinity of the portions of the vertebral spongiosa which are contiguous to the epiphysis.—*Ernst Bettmann, M.D., New York, N. Y.*

ABRISSBRUCH AM FERSENBEIN (Avulsion Fracture of the Os Calcis). Viktor Struppler. *Bruns' Beiträge zur klinischen Chirurgie*, CLXVI, 402, 1937.

There are authentic fractures of the os calcis due to tendon pull, which, however, do not appear to result from plantar flexion of the foot, but from marked hyperextension of the foot whereby the os calcis serves as a sort of pulley for the changing of the pull of the tendo achillis in the direction of the sole of the foot.

The author reports a case of maximum hyperextension of the foot without compression, caused by the patient's standing on the rungs of a ladder which broke, in which the upper part of the os calcis was torn out and the tendo achillis was ruptured.—*Ernst Bettmann, M.D., New York, N. Y.*

REGIONAL ANAESTHESIA FOR ORTHOPEDIC OPERATIONS. Charles F. McCuskey. *California and Western Medicine*, XLVIII, 179, March 1938.

The author presents a detailed description of cervical, brachial, and paravertebral blockings. As preliminary medication, a barbituric-acid and narcotic combination is recommended. The anaesthetic is made up fresh from a 20-per-cent. solution to the desired strength and a few minims of adrenalin are added.

Cervical block is obtained for laminectomy and reduction of fractures and dislocations by depositing the anaesthetic on the transverse processes in the operative region. The brachial plexus is blocked just above the middle of the clavicle and is used for operative work on both arm and shoulder. Paravertebral block is performed in the lumbar and thoracic areas for reduction of fractures and for fusion operations. Local anaesthesia provides increased safety, with reduction of operative shock and of pulmonary complications.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

SULLE CISTI DEL MENISCO. CONTRIBUTO CLINICO. (Cysts of the Meniscus.) H. Wolff. *La Chirurgia degli Organi di Movimento*, XXIII, 18, 1937.

Six cysts of the meniscus, all involving the lateral cartilage of the knee, have been found at the *Istituto Rizzoli* during the past thirty-four years. The total number of

lesions of the cartilages encountered during this period was eighty. They were distributed equally between the sexes. The ages of the patients ranged from fifteen to forty, although thirty-three years represented the upper age limit for the initiation of symptoms. Trauma occurred in two of the six cases. The medial cartilage was never involved.

Localized pain, aggravated after walking or use of the limb, and difficulty in motions of the knee without any actual locking are common. Limping and swelling of the knee are unusual.

The cyst is best seen with the knee extended and disappears when the knee is flexed, according to the general opinion. This was true in two of the author's cases, whereas in one case flexion brought out the cyst better. In half of the cases, the position of the knee made no change in the appearance of the cyst. In one case the knee lacked only from 15 to 20 degrees of full extension.

In each case treatment consisted of excision of the cyst. Local anaesthesia was used, and in all but one case a longitudinal incision was employed. Follow-up examinations from one month to thirty-two years after operation showed no recurrences.—*A. W. Ciani, M.D., Iowa City, Iowa.*

THE REGENERATION OF OSSEOUS TISSUE. Zygmunt Ambros. *Chirurgja Narzadów Ruchu i Orthopedja Polska*, X, 223, 1937.

This extensive article, based on material observed on Dr. Gruca's Service, presents a detailed review of the literature followed by a clinical study.

The author states that bone transplants have a stimulating effect on bone regeneration, and that they also serve as a mechanical support. The implantation of a graft is followed by hyperaemia which accelerates the separation of diseased tissue and stimulates osteogenic proliferation. According to Leriche, from four to eight days after the transplantation a process of connective-tissue proliferation with neoformation of vessels takes place. There is an initial decalcification of the transplant along the haversian canals, which is followed by an osteogenic regeneration. In from six to eight months the transplant is adapted anatomically and physiologically to its new rôle.

If the reason for the transplantation is purely mechanical, as in the shelf operation of the acetabulum, heteroplastic transplants are considered best. The heteroplastic material is resorbed and transformed like the autoplastic material but it offers a better support. For the treatment of pseudarthrosis, the heteroplastic bone is also considered better. The femora of the turkey are utilized for this purpose.

Dr. Gruca's method of heteroplastic-bone implantation was used in the treatment of bone infection. It led to definite cure in a comparatively short time.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

AUTOPLASTIC AND HETEROPLASTIC BONE TRANSPLANTS. Zygmunt Ambros. *Chirurgja Narzadów Ruchu i Orthopedja Polska*, X, 345, 1937.

The author states that heteroplastic-bone transplants have been used on Dr. Gruca's Service since 1932. During this time, sixty transplantations have been performed. Beef bone and bird bone, from which fat and, occasionally, protein have been removed, have been utilized for osteosyntheses, shelf operations, fractures, corrective osteotomies, arthrodeses, and pseudarthroses. It has been found that there is no difference in regeneration between the heteroplastic bone and the autoplastic bone. In fractures and in shelf operations the results with heteroplastic bone were found to be better because of the simpler operative technique.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

LAS PARÁLISIS DEL NERVIO MEDIANO EN LAS FRACTURAS DEL CODO (Median-Nerve Palsy in Fractures of the Elbow). Vicente Sanchís Olmo. *Cirugía Ortopédica y Traumatología* (Madrid), I, 231, 1936.

Of 236 cases of fracture of the elbow, 12 per cent. showed signs of median-nerve lesion alone or combined with injuries to the radial or ulnar nerves. In eleven cases Volkmann's

ischaemic contracture was present. There were twenty-three cases of primary palsy which appeared during the eight days following the production of the fracture. Only four cases were observed in which secondary palsy occurred because of retraction of the superficial fascia or direct pressure by the bone. After the typical fracture (extension position), the sharp end of the proximal fragment injures and stretches the nerve. The treatment consists in removing the bone or fibrous tissues causing impairment of nerve function. Prophylactic measures, consisting in perfect reduction without forcible manoeuvers, are to be recommended.—*Francisco P. Dueño, M.D., Madrid, Spain.*

OPERATIVE AND CONSERVATIVE TREATMENT OF TUBERCULOSIS OF THE SPINE. A COMPARATIVE STUDY. Harry Finkelstein, Benjamin B. Greenberg, Samuel A. Jahss, and Leo Mayer. *Journal of the American Medical Association*, CX, 480, Feb. 12, 1938.

A ten-year test was made by the authors to determine the comparative values of surgical and conservative treatments of tuberculosis of the spine. They reported the results of forty-three cases,—twenty-six were treated by fusion operations and seventeen by conservative methods. All of the patients were under twenty years of age.

The criteria for cure were as follows:

1. Pain, fever, muscle spasm, and body tilt must have disappeared for at least three months.

2. Abscesses must have disappeared, both clinically and roentgenographically, and sinuses must have closed.

3. Roentgenographically there must be seen increased calcification in the area of destruction, and cessation of all advance of the tuberculous process.

The average number of hospital days for those treated conservatively was 876; for those surgically treated, 1,215. The cases in which fusion was done, therefore, required about 40 per cent. longer hospitalization. Although the fusions themselves were successful, the pathological process in the vertebrae was apparently uninfluenced by the operation. Paraplegia developed in four cases following operation. In regard to an increase in deformity, no difference could be seen in the two groups. The condition progressed despite fusion.

The authors did find that the preoperative duration of the disease greatly influenced the hospitalization of the surgical cases. In cases in which the patients had had the disease six months or less before fusion, the average number of hospital days was 990; in cases of one to two years' duration, the average period of hospitalization was 1,210 days; and in those of over four years' duration, the average number of days was 480. It is suggested that fusion during the incipient stage of the disease would possibly alter the course of the disease. If early surgery is not done, then fusion should be postponed until the disseminative stage of the disease has passed and the patient shows positive signs of repair. The writers conclude, however, that tuberculosis of the spine is a chronic disease which runs its course little influenced by the orthopaedic surgeon.

Judged by the discussions, this article appears to have brought up a markedly controversial subject. In the discussions, the premises and the method of calculating the results are criticized. They also point out the facts that the fusion operation should not be used indiscriminately in all cases; its limitations should be respected, and end results are significant only in those cases in which surgery was unmistakably indicated.—*Harold M. Childress, M.D., Dallas, Texas.*

SACRO-ILIAC TUBERCULOSIS. Fred Thompson. *Journal of the American Medical Association*, CX, 1538, May 7, 1938.

The author reviews twenty-three cases of sacro-iliac tuberculosis which were treated by operative fusion.

All of the patients complained of preoperative localized pain which was greater

for some years against too much weight-bearing and also by consistent administration of vitamin D.

Cole states that "many roentgenograms of cases of proved osteitis fibrosa show a condition in the bone which simulates very closely that seen in some of the reported cases of chondrodysplasia". The case reported here suggests this on superficial examination, although absence of a generalized granular osteoporosis and generalized cortical thinning should be considered. Clinically there is also lacking the usual asthenia



FIG. 1

Symmetrical involvement of both tibiae. Linear streaking is obvious in both. The middle portion of the shafts is without evidence of demineralization, mottling, streaking, or punctate areas.

of the isolated foci were studied. This was amplified by a study of their course, age group, and relation to other foci. The lower end of the femur was involved in 52.5 per cent., the upper end of the tibia in 40 per cent., and the patella in 7.5 per cent. The fibula was not found to be involved. It was frequently observed that even large foci with destruction were not apparent roentgenographically. The differential diagnosis was found to present certain difficulties.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

GOLD TREATMENT OF ARTHRITIS. A REVIEW OF 900 CASES. Stanley J. Hartfall, Hugh G. Garland, and William Goldie. *The Lancet*, II, 784, 838; 1937.

This report is based on a study over a four-year period of the results obtained from treatment by gold salts, both intravenously and intramuscularly. A review of 690 cases of rheumatoid arthritis treated by this method gave the following results:

| *Result* | *Per Cent.* |
|---|---|
| Apparent cure | 9.9 |
| Marked improvement | 56.8 |
| Moderate improvement | 13.0 |
| Slight improvement | 6.2 |
| No improvement | 8.9 |
| Condition worse | 2.5 |
| Death (various causes) | 2.7 |

One course of treatment consisted of an injection once a week for a period of twelve weeks. It was found that two courses of treatment gave the best results.

Improvement usually began midway through the first course. Experience showed that this treatment was most beneficial in rheumatoid arthritis, and the authors recommend its use only in this type.

The results of gold treatment in sixty-eight cases of osteo-arthritis are as follows:

| *Result* | *No. of Cases* |
|---|---|
| Cure | 0 |
| Marked improvement | 10 |
| Moderate improvement | 11 |
| Slight improvement | 19 |
| No improvement | 22 |
| Condition worse | 6 |

Toxic reactions were seen in 35.3 per cent., excluding very mild single reactions which would bring the total to 41.9 per cent. Toxic reactions are discussed in regard to type, prevention, and treatment.

Relapse may occur, especially after the first course, but, if treatment is continued, relapse is rare.—*Herbert T. Browne, M.D., Iowa City, Iowa.*

RUPTURE OF THE SUPRASPINATUS TENDON. C. H. Gray. *The Lancet*, I, 483, 1938.

The author reviews the subject of the treatment of partial and complete rupture of the supraspinatus tendon with a discussion of the anatomy, pathogenesis, and clinical features. He reports fifteen cases, twelve of which were associated with fractures about the shoulder joint. He finds that limitation of active abduction is a characteristic feature and recommends an exploratory operation where signs and symptoms persist, after an adequate period of conservative treatment.—*A. R. Shands, Jr., M.D., Wilmington, Delaware.*

when standing and walking than when lying down. The average duration of symptoms prior to surgery was two and one-half years. The current so-called signs of sacro-iliac disease were absent as frequently as they were present. Sciatic pain seemed to appear most often in those cases in which abscesses were present. Preoperative diagnosis was not easy,—all had positive Mantoux reactions, and x-ray and laboratory studies did not give conclusive evidence. A positive Mantoux reaction confirmed, as a rule, a tentatively made diagnosis. Twenty-one of the operated cases had proved tuberculosis of the joint.

Arthrodesis was done through a posterior approach using grafts chipped from the ilium and sacrum. Soft-tissue abscesses were avoided when possible, but if in the field of operation they were excised or their walls were cauterized. A tight wound closure was made in an effort to procure primary healing. Primary closure occurred in 25 per cent. of those who had sinuses and in 41 per cent. of those in whom no sinus was present before operation. Draining postoperative sinuses developed in 52 per cent. of all the cases. In most instances the sinus closed in five months.

The average postoperative period in bed, for patients who had no demonstrable active tuberculous foci elsewhere, was three months. Others, with active pulmonary lesions, or with elevated temperature, pulse rate or sedimentation rate, were kept in bed until, clinically, the activity had subsided. This required, in some, up to three years. The clinical signs as noted above, and not the x-ray, were used to indicate when the process had subsided sufficiently to permit normal activity.

Mortality was 21 per cent., all deaths occurring within one year after operation.

The writer concludes that surgical fusion of tuberculous sacro-iliac joints results in cure of the local process.—*Harold M. Childress, M.D., Dallas, Texas.*

MERALGIA PARAESTHETICA. A REPORT OF ONE HUNDRED AND FIFTY CASES. Arthur D. Ecker and Henry W. Woltman. *Journal of the American Medical Association,* CX, 1650, May 14, 1938.

Meralgia (hip pain) paraesthetica is produced by changes in the sensory lateral femoral nerve. The authors report a study of 150 cases. They point out the exact course of the nerve, especially its angulation as it emerges from the pelvis, and its course beneath the fascia lata.

The condition appears to be due to a neuritis produced by a selective toxaemia or/and by trauma. Other probable causes are intra-abdominal and intrapelvic pressure on the nerve, and direct injury to the nerve as it lies in a fascial bed in the thigh. Middle-aged men are most commonly affected. Obesity may be an etiologic factor by altering posture, which would permit the inguinal ligament and fascia to exert pressure or traction on the nerve. Five of the cases had lesions affecting the nerve roots within the spinal canal. One of these developed bilateral meralgia shortly after the administration of a spinal anaesthesia.

Numbness over the anterolateral area of one thigh is usually the earliest and most frequently found symptom. Tingling, pain, and a burning sensation may also be present. These are more severe and persistent upon prolonged standing by the patient. The chances are good for spontaneous recovery if the symptoms have been present for less than two years.

Treatment is at first conservative. If the condition remains unimproved, nerve resection should be done.—*Brandon Carrell, M.D., Dallas, Texas.*

TUBERCULOUS FOCAL CHANGES ABOUT THE KNEE JOINT AS REVEALED BY ROENTGENOGRAPHY. V. P. Gratziansky. *Khirurgiya,* V, 122, 1937.

Between 1919 and 1935, 1183 cases were observed in the Institute of Surgical Tuberculosis. Of these 116 cases, or 9.8 per cent., were found near the knee joint. The hip joint was involved in 13.8 per cent. The frequency, localization, and configuration

Excellent results were obtained in five cases. Of twenty-seven cases with painful dislocations, perfect results were obtained in three; very good results in ten; fair in nine; and poor in five. The cause of the failures was attributed to poor shelving. The shelves were too small, or too high, or posterior to where they should have been, or oblique. In ten cases in which there were arthritic changes the results were inconclusive, as the patients were operated upon a long time ago when the procedure had not been perfected. In all patients over five years of age attempts to bring the femoral head into the acetabulum or near it resulted in postoperative arthritis with immobilization of the hip in the position of plaster fixation. This was painless, but accompanied by a progressive atrophy of the bone of the upper femur and acetabulum. In three or four years, however, the lesion began to regress, and remarkable recovery ensued. Eight such cases are mentioned.—*Robert B. Portis, M.D., Iowa City, Iowa.*

Die Differentialdiagnose der traumatischen oder spontanen Entstehung der Ruptur der langen Bicepssehne (Differential Diagnosis of Traumatic and Spontaneous Rupture of the Long Head of the Biceps Brachii). Fr. Gillitzer. *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, XLIV, 542, 1937.

Spontaneous ruptures are usually characterized by their occurrence high up on the tendon, often in the intertubercular sulcus. In contrast to this, the traumatic ruptures mostly occur near the myotendinous junction, even in the muscle itself. Whereas a hematoma is rarely found in a spontaneous rupture, it is almost always present in a traumatic rupture. The tendon is dull and usually frayed in spontaneous rupture, but in traumatic rupture it is glistening and the tear is clean-cut. Inflammatory signs appear in spontaneous rupture, but not in acute traumatic rupture.

Spontaneous ruptures occur almost always in persons over forty and most often in workers in certain occupations, such as glass-blowers, trip-hammer operators, trap-drummers, etc. These workers use their shoulders a great deal.—*J. Vernon Luck, M.D., Iowa City, Iowa.*

Treatment of Acute Suppurative Inflammation of the Knee Joint. P. I. Goloborodko. *Novy Khirurgichesky Arkhiv*, XXXVII, 696, 1937.

The following method of treatment is used in the Clinic of the Prof. Rose Institute for Postgraduate Study of Physicians. An x-ray study of the joint to establish bone involvement is made. An aspiration of the infected joint is performed, and the fluid is examined bacteriologically. The joint is then filled under pressure with 0.5 per cent. to 1 per cent. solution of novocain. Subsequently one cubic centimeter of a mixture of phenol (30 per cent.), camphor (60 per cent.), and pure alcohol (10 per cent.) is injected. The trocar remains *in situ* plugged with a sterile rubber stopper. The leg is placed in flexion on a splint. In two days the joint is again aspirated, and the fluid is examined. If there is no improvement and the bacteriology is the same, a wide arthrotomy proposed by the author is performed. Four incisions are made, through which the tibial collateral ligament is cut transversely, and the capsule and the external fibers of the gastrocnemius are resected. If the condition remains unchanged, a resection of the joint, proposed by Prof. Rose, is done. Two incisions are made,—one laterally between the iliotibial band and the biceps and one medially between the sartorius and the adductor magnus. The articular surfaces of the condyles and the tibia are widely resected through these incisions, and, if necessary, the synovial membrane is excised. The author claims brilliant results.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

L'Ostéotomie intertrochantérienne dans le traitement des pseudoarthroses du col du fémur (Intertrochanteric Osteotomy in the Treatment of Pseudarthroses of the Femoral Neck). V. Putti. *La Presse Médicale*, XLV, 1841, 1937.

Putti is of the opinion that the treatment of recent fractures of the femoral neck should include transtrochanteric osteosynthesis. Besides the age of the fracture and its type, the result of this osteosynthesis will be dependent upon the mechanical resis-

TREATMENT OF CERTAIN JOINT LESIONS BY INJECTION OF LACTIC ACID. W. Grant Waugh. *The Lancet*, I, 487, Feb. 26, 1938.

The author has observed that there is a development of acidity in the traumatic effusions of joints, similar to that found in a primary hematoma surrounding a fracture. It has been assumed that the development of this acidity is a physiological response to trauma to excite local leucocytosis and repair. In an attempt to imitate this physiological reaction in joints, the author has injected a solution of lactic acid and novocain into the pathological joint in cases diagnosed as traumatic arthritis or recurrent synovitis. He believes that the injection of this solution of lactic acid and novocain hastens the return to normal function. He has also observed that the synovial fluid in rheumatoid arthritis shows an abnormal alkalinity and has injected the same solution into a number of these joints with subsequent improvement.

His conclusions are that in rheumatoid arthritis the possibilities of restoring function by the injection of lactic acid deserve further investigation, but for the present this method should be reserved for those cases showing severe disorganization of joints.—*A. R. Shands, Jr., M.D., Wilmington, Delaware.*

GOUT. Leslie C. Hill. *The Lancet*, I, 826, April 9, 1938.

The author has reviewed ninety-three of his own cases of gout over a three-year period. The following are the significant findings:

1. A family history of gout is obtained in about 50 per cent. of the ninety-three cases.
2. There is a strong suggestion that a high proportion of those cases in young people are secondary to nephritis.
3. Tophi are present in about half the cases.
4. There is a definite tendency for the initial attack to occur at night.
5. Spring is clearly the season of choice for gout, and autumn next.
6. A rapid return to normal following clinical improvement is a characteristic feature.
7. The blood uric acid is not always above normal. There is no essential abnormality of the blood urea.
8. There is no evidence in this series of a high blood calcium or of a glycosuria.—*A. R. Shands, Jr., M.D., Wilmington, Delaware.*

LE SYNDROME KOEHLER-PELLEGRINI-STIEDA (Köhler-Pellegrini-Stieda Syndrome). I.-N. Odessky. *Lyon Chirurgical*, XXXIV, 272, 1937.

In discussing this syndrome, the author points out that the shadow of increased density appearing at the upper medial corner of the medial condyle of the femur, while it is usually post-traumatic, is not present immediately after the injury; it changes its shape often during observation; and it is not continuous with the bone of the femur in many cases. It is often associated with increased density of shadow in the tibial collateral ligament. Fracture with a displaced fragment and periosteal osteophyte is, therefore, unlikely. It is a calcification and later, at times, an ossification of soft parts in the region, and may be associated with unabsorbed hemorrhage and callus formation. The treatment is non-operative conservative therapy.—*Robert B. Portis, M.D., Iowa City, Iowa.*

RÉSULTATS ÉLOIGNÉS DES BUTÉES OSTÉOPLASTIQUES DANS LES SUBLUXATIONS CONGÉNITALES DE LA HANCHE (Late Results of Osteoplastic Shelving in Congenital Dislocation of the Hip). Tavernier et Trillat. *Lyon Chirurgical*, XXXIV, 490, 1937.

The authors discuss the late results in forty-nine cases. The ages of the patients at operation varied from three to twenty-seven years. Most of the patients were near puberty, and only seven were over eighteen years of age. Twelve patients were operated upon for mild instability of the hip as a prophylaxis against true dislocation. Poor results and later dislocations occurred in five cases. In two cases stable but painful hips resulted.

knee had gone out of place, and the knee cap had slipped to the outer side of the knee. In following years there had been many recurrences. When the patient was fifteen years of age, dislocation of the left knee had occurred, but the reactions had not been so severe nor subsequent dislocations so frequent as in the right knee. Slipping of both knee caps had occurred at increasingly frequent intervals, and for the past six or seven years the patient had never been entirely free from some discomfort. Some surgery had been done on the right knee fifteen years previously.

Examination disclosed a fixed lateral dislocation of the right patella. The left knee was normal, but, on flexion to 40 degrees, a spontaneous lateral dislocation of the patella occurred. Roentgenographic examination showed lateral dislocation of the right patella and abnormal lateral position of the left. Marked hypertrophic changes and evidence of several loose bodies in the knee joints were also seen.

Operation disclosed an osteochondritis dissecans of both medial femoral condyles and thickened synovial membrane. The quadriceps tendon in each knee was freed and reefed medially. The insertion of both patellar ligaments, together with a large fragment of bone, was transplanted to the medial aspect of the tibia after preparation of a suitable bed. Twenty-one days after operation the patient was able to be up in a chair.

The operative procedure described has been used thirty-seven times with only one failure.—*F. Polesky, M.D., Iowa City, Iowa.*

CONGENITAL BONE DYSPLASIA. Sylvester Ford. *Radiology*, XXX, 117, Jan. 1938.

Congenital bone dysplasias are divisible into two main growths,—the malacic, with deficiency in subperiosteal bone production and osteoporosis; and the hyperostotic, with overproduction of cortical bone. In the first group falls osteogenesis imperfecta, which has two forms,—the congenital and the late. Osteogenesis imperfecta congenita is characterized by multiple fractures showing evidence of healing *in utero*. The patients survive only a few hours. They are always born to normal parents. There is no abnormality in the blood chemistry of either patient or parents.

Osteogenesis imperfecta tarda, also called osteopsathyrosis and fragilitas ossium, presents fractures incident to minor traumata and involving the diaphyses of long bones and ribs, the majority occurring between the ages of three and eleven and rarely after twenty. These fractures heal rapidly, often with deformity. There is a high degree of osteoporosis, and the cortex is thin and deficient in lime salts. Apparently there is a non-hereditary type and a hereditary type which is part of a syndrome in which blue sclera are a dominant characteristic. Key applies the term "hereditary hypoplasia of the mesenchyme" to the latter. The blue sclera are always present both in the patient and in one parent. There is no skipping of generations. Associated with it may be: (1) multiple fractures; (2) deafness, of the otosclerotic type; and (3) loose joints and frequent dislocations. Treatment is symptomatic. Large doses of viosterol or of parathyroid extract are contra-indicated.

Osteitis fibrosa is considered a congenital bone dysplasia with strong hereditary tendencies.

Osteitis deformans is thought also to have hereditary tendencies.

Congenital bone dysplasias characterized by hyperostotic changes comprise a small group of rare conditions. Hereditary and familial factors appear to be definitely present. In this group are included marble bones, also known as congenital osteosclerosis and osteopetrosis. The changes consist in increase of hard cortical bone, with partial or complete obliteration of the marrow cavity. The condition is more or less generalized and occurs in the first age period.

Melorheostosis, or "flowing hyperostosis", is characterized by non-generalized proliferation of cortical bone along the shafts of the long bones of a single extremity and the disposition of irregular bony masses in the shoulder and the hip. The average age of onset is twenty years.

Osteopoikilosis, or "disseminated condensing osteopathy", shows small areas of in-

tance of the two fragments. Roentgenographic examination is the most dependable means of determining this capacity. Where the roentgenographic shadow is homogeneous in both fragments, the biological activity and the mechanical resistance of the fragments are the greatest. Where the head or neck shows a mottling or more diffuse bone absorption, the likelihood of successful osteosynthesis is questionable. In such cases, and in those in which pseudarthrosis is already present, Putti suggests transtrochanteric osteotomy.

The method of transtrochanteric osteotomy depends upon the elimination of the cervical angle and the displacement of the upper end of the distal osteotomized shaft, so as to support both the fractured head and the osteotomized portion of the trochanter. Depending upon whether or not the shaft has been displaced upward, the site of the osteotomy may be higher or lower, but, in any event, it must always be between the two trochanters. The procedure is carried out under local anaesthesia with the patient in dorsal decubitus. The affected leg is held in slight flexion, abduction, and internal rotation. The skin incision is made directly down on the outer side of the greater trochanter. The upper end of the femur is exposed subperiosteally and the bone is cut at the base of the greater trochanter. This brings the line of incision just above the level of the lesser trochanter. The incision must be directly at right angles to the axis of the femur, and the femur should be displaced medially sufficiently to bring the upper end of the distal fragment beneath both the head and the base of the greater trochanter. Plaster is applied after skin closure.

The author has operated upon twenty-one patients since 1930. There were four males and seventeen females. The age of the patients varied between forty and seventy-seven. One patient succumbed to an intercurrent infection three months after operation. In one case, the result was unsatisfactory, because of insufficient medial displacement of the osteotomized fragment. In all the others, the results were entirely satisfactory. The author insists upon the advisability of maintaining the limb in slight flexion during the period of healing, in order to facilitate function of the hip in flexion.—*Henry Milch, M.D., New York, N. Y.*

La radiothérapie du deuxième ganglion sympathique lombaire dans les coxarthries (Radiation of Second Lumbar Sympathetic Ganglion in Arthritis of the Hip). Duhem, Moro, et Montmignaut. *La Presse Médicale*, XLVI, 153, 1938.

Following the results obtained by Massart, after injection of the ganglion with local anaesthetics, the authors were inspired to effect similar results by radiation of the lumbar sympathetic ganglia. The area irradiated was ten centimeters square and was centered about three centimeters lateral to the mid-line, at the level of the second lumbar vertebra. The factors used were 180 to 200 kilovolts, with an intensity of three milliamperes, filtered through five-tenths of a millimeter of copper and two millimeters of aluminum at a focal distance of forty centimeters. The dosage was about 150 roentgen units at each of six treatments, given twice weekly.

Twenty-five cases were treated. In four cases, amelioration of the pain occurred after three treatments; in six, after four treatments; in eight, after six treatments. In cases where low dosage was employed, a second course of treatment, after the lapse of a month, was necessary. No statement as to the duration of the relief was made.

The authors believe the effect is obtained through a "functional ganglionectomy". The effect is merely to reduce pain and so to permit a greater range of motion in the affected joints. No change is, of course, to be expected in the roentgenographic appearance of the advanced lesions.—*Henry Milch, M.D., New York, N. Y.*

Bilateral Recurrent Dislocation of the Patella J. D. B. Galloway and H. B. Macey. *Proceedings of the Staff Meetings of The Mayo Clinic*, XII, 783, 1937.

The authors report the case of a woman, forty-eight years of age, who complained of pain in both knees and outward slipping of both knee caps. At the age of six, the right

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# TREATMENT OF SCOLIOSIS BY THE WEDGING JACKET AND SPINE FUSION

## A REVIEW OF 265 CASES *

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The first spine-fusion operation for scoliosis in the New York Orthopaedic Dispensary and Hospital was performed in 1914. In 1931, Hibbs, Risser, and Ferguson reported the results in the first 360 patients so treated, covering the thirteen years from 1914 to 1927. The present report embraces 301 patients who were operated upon from 1928 to 1935, inclusive, and continues the study of all cases of lateral curvature treated by fusion in the Hospital through 1935. This latter period coincides approximately with that during which the wedging jacket, devised by Risser, has been used in correcting scoliosis, and thus enables us to compare the results of treatment by this means with those obtained by the older methods of simple traction and traction jackets. Two hundred and sixty-five patients had been treated by the wedging jacket at the end of 1935. The present study deals chiefly with them. It convinces us of the marked superiority of this over other methods of correcting scoliosis, and confirms our belief that fusion of the spine in the right area will maintain correction of a curve, after a slight initial loss in some cases.

The use of the wedging jacket, followed by spine fusion, is a difficult procedure, demanding a thorough understanding of all principles involved and the closest attention to many details, the neglect of any one of which

* Read at the Annual Meeting of the American Orthopaedic Association, Atlantic City, New Jersey, May 5, 1938.

1. Longitudinal incision between the flexor carpi ulnaris and the extensor carpi ulnaris with resection of one inch of the ulna.

2. Removal of cartilage in the radio-ulnar joint and introduction of a wooden screw to hold the radius and the ulna.

3. Suture of the pronator quadratus to the tendon of the extensor carpi ulnaris.

4. Subsequent cuneiform osteotomy of the radius and removal of the wooden screw, followed by immobilization in plaster for two months.

This procedure resulted in restoration of supination and of pronation, correction of the deformity, and only slight limitation of flexion. It should be used in adults only.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

THE TREATMENT OF CONTRACTURES AND ANKYLOSIS OF TUBERCULOSIS OF THE KNEE. B. Špišić. *Slovanský Sborník Ortopedický*, XI, 307, 1937.

Of 370 cases of joint tuberculosis, seen on the Orthopaedic Service at the University Clinic in Zagreb during the past six years, 101 involved the knee. The flexion contracture of this joint is now treated by the author primarily with the turnbuckle cast and the Quengel attachment. By this method almost all of the contracture can be corrected in from eight to fourteen days. Should some contracture remain or be associated with valgus, varus, or subluxation deformities, a para-articular osteotomy completes the correction.

In a series of 300 cases of tuberculosis of the knee, seen during the past fifteen years, two arthroplasties have been performed. The first patient was a male, twenty-one years old, with bilateral ankylosis,—one knee was ankylosed in 180 degrees and the other in 85 degrees. Proof of tuberculosis or length of time since quiescence are not stated. Both knees were reconstructed with satisfactory results. The second patient was a female, twenty-two years old, with ankylosis in flexion and valgus from a childhood tuberculosis. Eighteen months after arthroplasty of the knee, 60 degrees of motion was present.

The author states that a favorable outcome usually follows the use of the proper technique in a patient with good musculature if the limb is immobilized in a hip spica for four weeks after operation and then fitted with a long leg brace to relieve weight pressure. Physiotherapy apparently plays a minor part.—*W. R. Hamsa, M.D., Iowa City, Iowa.*

TOTAL TENDON TRANSPLANT FOR SLIPPING PATELLA. A NEW OPERATION FOR RECURRENT DISLOCATION OF THE PATELLA. Emil D. W. Hauser. *Surgery, Gynecology and Obstetrics*, LXVI, 199, Feb. 1938.

The author discusses the etiology of slipping patella and reviews the literature and various methods of treatment.

He then gives the technique of his own operation. The patella, conjoined tendon, and patellar ligament are adequately exposed by a curved incision, beginning well above the patella, curving around its lateral aspect, and then coming back to the mid-line about a half inch below the tibial tubercle. The patellar ligament is dissected free down to its insertion. A block of bone about one-half an inch square, including the attachment of the patellar ligament, is removed from the tibia. The entire lateral side of the patella is then freed by dividing the fascia down to the capsule. The dissection is next carried along the lateral side of the conjoined tendon well up into the area of the fascia, lateral to the vastus lateralis. The fascia is divided down to the capsule, but the operation remains extra-articular. The patella is then drawn medially by means of the patellar ligament which is buried in a previously prepared bed in the tibia. Over this the periosteum is sutured. The cavity of the old bed of the tibial tuberosity is filled in with bone removed from the prepared bed.

A number of cases are presented. The results have been uniformly good.—*P. F. Siman, M.D., Iowa City, Iowa.*

and weakness, polyuria, and anaemia, which are characteristic of Recklinghausen's disease.

The metabolism study shows no radical departure from the normal, which offers a definite differential criterion from osteitis fibrosa cystica where hypercalcaemia, hypophosphataemia, elevated phosphatase, and a markedly negative calcium balance are associated with preponderant urinary excretion of calcium.

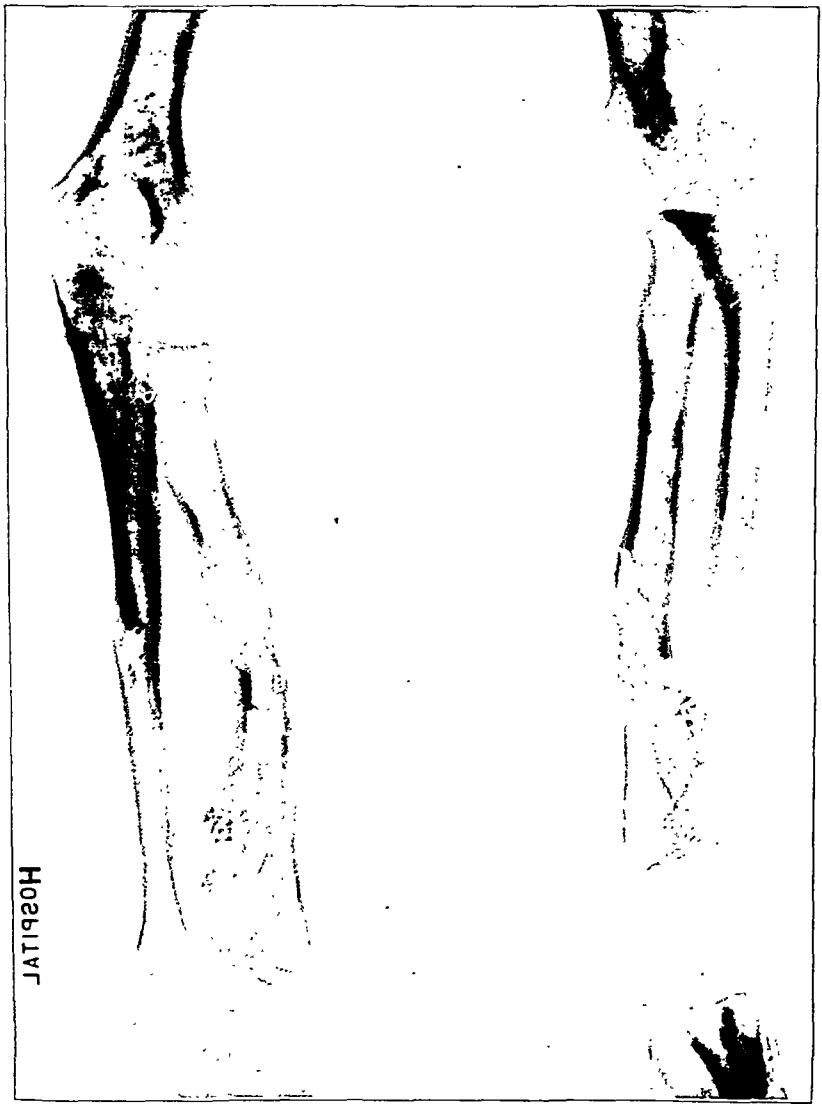



FIG. 2

The right radius is thickened and in the lower portion the typical streaked and mottled cystic area is obvious. The ulna is less striking, but presents an appearance more easily confused with osteitis fibrosa cystica except for the normal mineralization of the upper shaft. (The roentgenogram of the bones of the left arm is not shown as these bones were entirely normal.)

may result in marring the outcome or in complete failure. Unless one is willing to master all of these points thoroughly and to do all of the hard work entailed, he had better not undertake it at all. Although it is possible for a surgeon working alone to carry out this method of treatment, yet if many patients are to be treated, it is of great advantage to have an experienced team, including an orthopaedic surgeon who can devote the major part of his time to the task, a roentgenologist who understands the special details of the problem, and nurses who have been trained to care for the patients in their jackets.

Correction of the curve and a fusion operation are not advised in all cases of scoliosis. In the eight-year period covered by this study, 1498 new cases of scoliosis were seen in our Clinic and only 287 patients, or 19 per cent. of the entire number, were operated upon. Additional experience confirms our belief that increase in a curve is coincident with growth of the spine, and that when the latter stops the curve reaches a static condition.[4] The following are the more important indications for correction and fusion:

1. A curve which is progressing, in a growing child.
2. A severe curve with imbalance of the trunk, whether or not the patient is beyond the period of growth.
3. A deformity which is causing pain or fatigue. In some of these cases an operation may be performed without previous correction.

At our Hospital the routine management of a patient with scoliosis begins by referring him to the special scoliosis clinic. A history is taken and an examination is made, including measurements of total height, of sitting height, and of the length of the lower extremities. In many cases a study of the vital capacity is made. Roentgenograms are made of the spine in the standing and in the lying positions, from which the curves are measured, and photographs are taken. If it is obvious that correction and operation are necessary, this is advised after the examinations have been completed. In the majority of cases, further observation is indicated in order to determine whether or not the curve is progressing. During this time, exercises are carried out in the gymnasium, not with any intention of correcting or arresting the deformity thereby, but in order to improve posture and to hold the patient's interest until it is decided whether or not any other treatment is necessary. In three patients a measurable improvement did occur after corrective exercises.

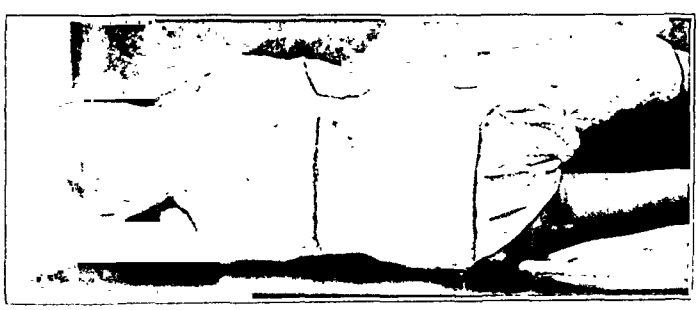


FIG. 1

Jacket before cutting and wedging. Patient with right thoracolumbar curve.

The jacket now employed is essentially

the same as that first used by Risser in 1927 and described by him in 1931[3]. It has been modified in a few details, the most important of which is that it now is applied with only enough traction to hold the head in position and without depending upon this force for any correction. During the application of the jacket, the head is held toward the side of the concavity of the curve. This is done in order to prevent undue stretching of the brachial plexus, which was a troublesome complication in some patients before this expedient was adopted. The hinges are now placed more eccentrically toward the convexity of the curve, and it is not considered necessary to have them opposite the center, especially in the thoracic region. In these cases they often are below the center or apex.



FIG. 2

Jacket during process of wedging.

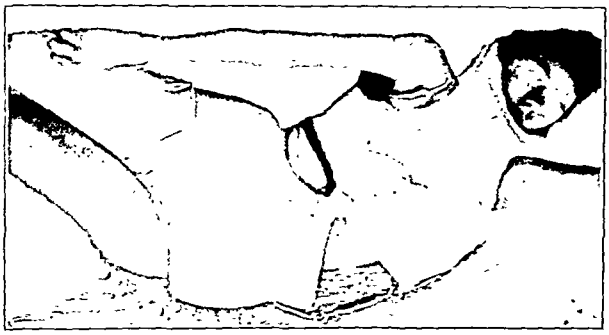


FIG. 3

Front view of jacket at same stage as that shown in Fig. 2.

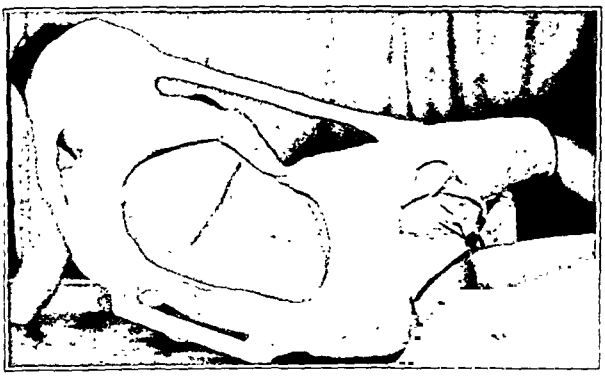


FIG. 4

Jacket after completion of wedging, prepared for the operation.

The greater ease by which a curved rod can be straightened by bending it, rather than by making traction upon its ends, can be demonstrated mathematically as well as by practical test. In addition to its greater effectiveness in straightening the primary curve, the wedging jacket has the great advantage of simultaneously increasing the compensatory curve. This change in the secondary curve is maintained, of course, only while the patient is in the jacket. After the latter has been

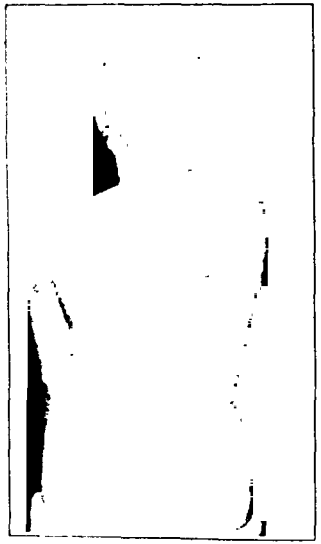


FIG. 5

Case 1. Patient aged ten years. Before treatment.



FIG. 6

Case 1. Six years after operation.

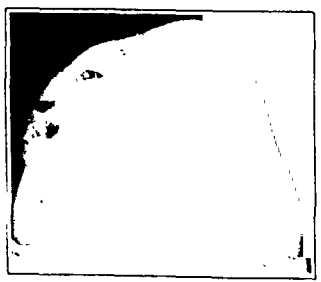


FIG. 7

Case 1. Forward bending before operation.



FIG. 8

Case 1. Forward bending after operation. Note correction of rotation.




FIG. 9

Case 1. Roentgenogram of patient sitting. Before operation.

removed, the compensatory curve should straighten in proportion to the degree that the primary curve has been corrected.

This temporary increase in the secondary curve is of great importance, however, and is one of the main factors contributing to the success of this jacket. It means that, in cases in which the primary curve can be corrected only partially, body balance still can be reestablished and marked clinical improvement can be obtained by continuing the fusion a few vertebrae beyond the primary curve into the secondary one. In this way patients with severe curves of long standing, some of which can be corrected to only a small degree, can be greatly helped and their appearance markedly improved.

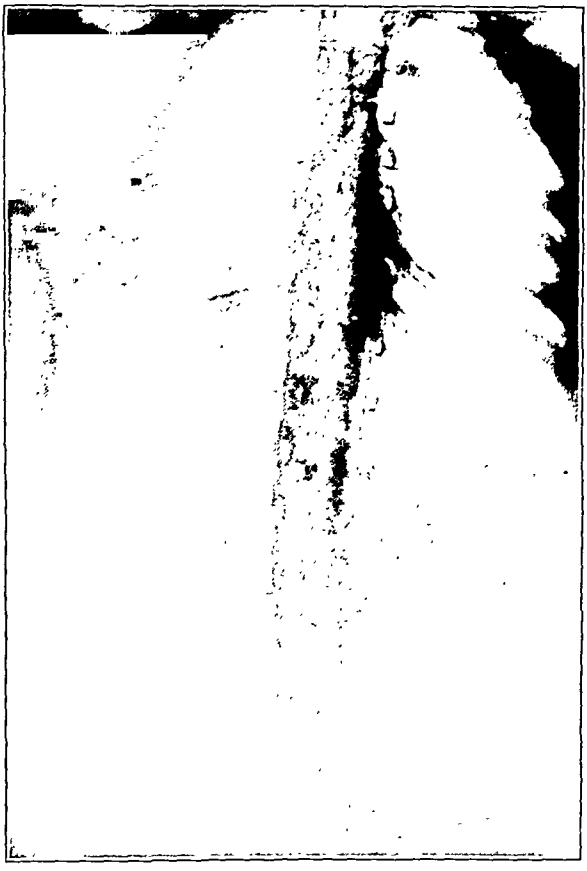


FIG. 10

Case 1. Roentgenogram of patient sitting. Six years after operation.

Identification of the primary curve is, of course, necessary before the application of the jacket. Usually this presents little difficulty, but in some cases it may be a puzzling problem. Ferguson has described the criteria which are used in this determination, and only the more elementary rules are repeated here:

1. In the case of three curves, the middle one usually is the primary curve.

2. The greater curve, or the one toward which the trunk is shifted, usually is the primary curve.

3. When, in the sitting position, the pelvis is elevated on the side of the convexity of the lumbar curve, if this curve is compensatory, it will tend to straighten; but, if it is primary, it will not.

Another important matter is the selection of the area of the spine to be fused. This phase of the procedure has been described fully in previous articles.[1] After the curve has been corrected to the extent possible or desired, the jacket is prepared for the operation. It is first reinforced

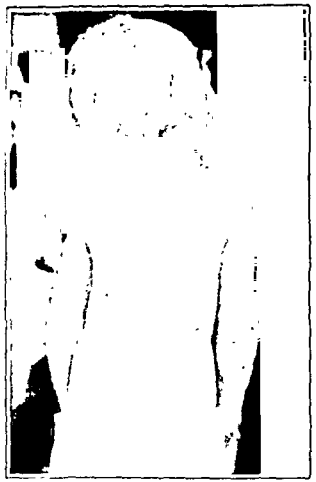


FIG. 11

Case 2. Patient aged five years. Before treatment.



FIG. 12

Case 2. Four years after operation.

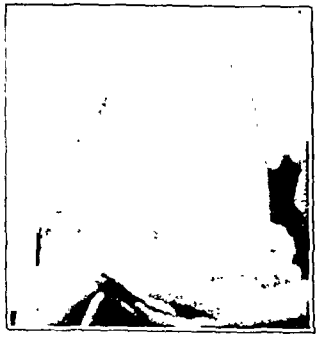


FIG. 13

Case 2. Forward bending before operation.



FIG. 14

Case 2. Forward bending after operation, showing correction of rotation.



FIG. 15

Case 2. Roentgenogram of patient standing. Before operation.

with struts constructed of basswood and plaster. A snugly fitting vest of plaster is then applied. Finally, a window is removed from the back in the region to be operated upon. A transverse mark is made with gentian-violet stain on the skin over one of the spinous processes. A wire is placed on this, and a roentgenogram is taken. Without a mark of this kind, it would be impossible to ascertain exactly which vertebrae are being operated upon. A mistake of even one vertebra in the area of fusion in many cases would have a serious effect upon the result.



FIG. 16

Case 2. Roentgenogram of patient standing. Five years after operation.

The same roentgenogram is used in determining the limits of the fusion:

1. If the primary curve has been straightened completely, the fusion is limited to the vertebrae included in it. It is important that the end vertebrae be not overcorrected, which might occur in a mild flexible curve.

2. When correction is not complete, it may be advisable to extend the fusion beyond the limits of the primary curve. The objective should be to extend the fusion to the point where the upper surface of the upper vertebra will be parallel to the lower surface of the lower vertebra. These surfaces should be at right angles to a line joining their centers. The time required for correction of the curve, including the application of the jacket and its preparation for the operation, is from three to four weeks.

The Hibbs method of fusion was used in all cases. If more than five vertebrae are to be included in the fusion, the operation is done in two or more stages. Since this rule was adopted, the occurrence of shock has been minimized and the mortality has been reduced from 1.9 to 0.66 per cent. An intravenous infusion of glucose is given during the operation and, if necessary, a blood transfusion is given afterward. The latter sel-

dom is needed, but is used for less serious indications now than formerly. The postoperative course usually is uneventful and in the great majority of cases is not attended by a marked rise in the temperature or in the pulse rate.

The patient remains in the original jacket for three months after the last operation, and during this time is kept in bed. The jacket is then removed and a so-called "semibent" jacket is applied. It is put on with the patient lying supine on a strip of canvas and without any attempt to straighten the back more than occurs naturally. A strap of plaster is included over the shoulder opposite the curve in order to hold the head and neck over. Since the compensatory curve does not straighten fully, the patient still is bent over toward the side of the primary curve. The patient is now permitted to be up. At the end of three more months, the jacket is again changed, and the shoulder strap which was incorporated in the semibent jacket is omitted. When the last jacket is put on, the spine usually has nearly but not completely become straight. This jacket is removed in three months and, if the roentgenograms indicate that the fusion is continuous and mature, no other plaster is applied. The strength of the fusion is judged in relation to the size of the patient and the amount of correction that has been obtained. Therefore, the question of whether jackets shall be continued longer than nine months after the operation must be decided from the factors in each case.

A roentgenographic examination should be made each time the jacket is changed in order to detect at the earliest possible moment any

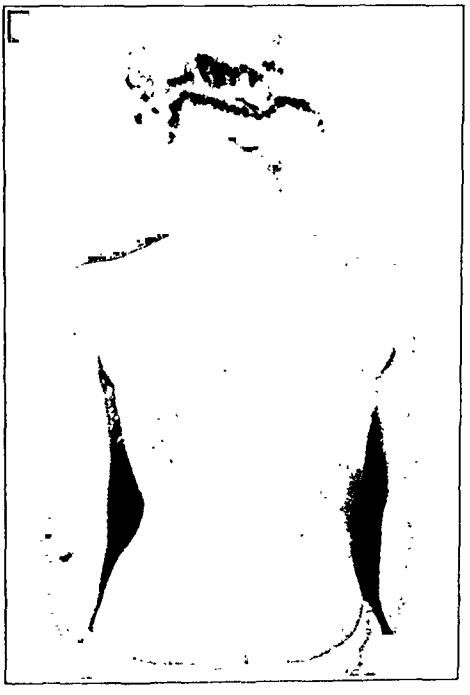


FIG. 17

Case 3. Patient aged nineteen years. Before treatment.

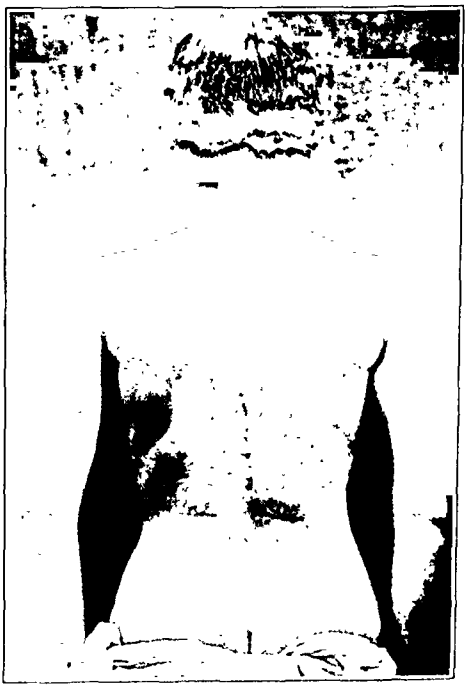


FIG. 18

Case 3. Patient at completion of treatment.



FIG. 19

Case 3. Roentgenogram of patient standing. Before treatment.



FIG. 20

Case 3. Roentgenogram nine months after correction and fusion. Loss of correction has occurred between the first and second lumbar vertebrae, due to pseudarthrosis.



FIG. 21

Case 3. Roentgenogram three years later than Fig. 20. Correction was regained in the jacket, and pseudarthrosis was repaired.



FIG. 22

Case 4. Patient with left thoracolumbar curve. Before operation.



FIG. 23

Case 4. Three years after correction and spine fusion.

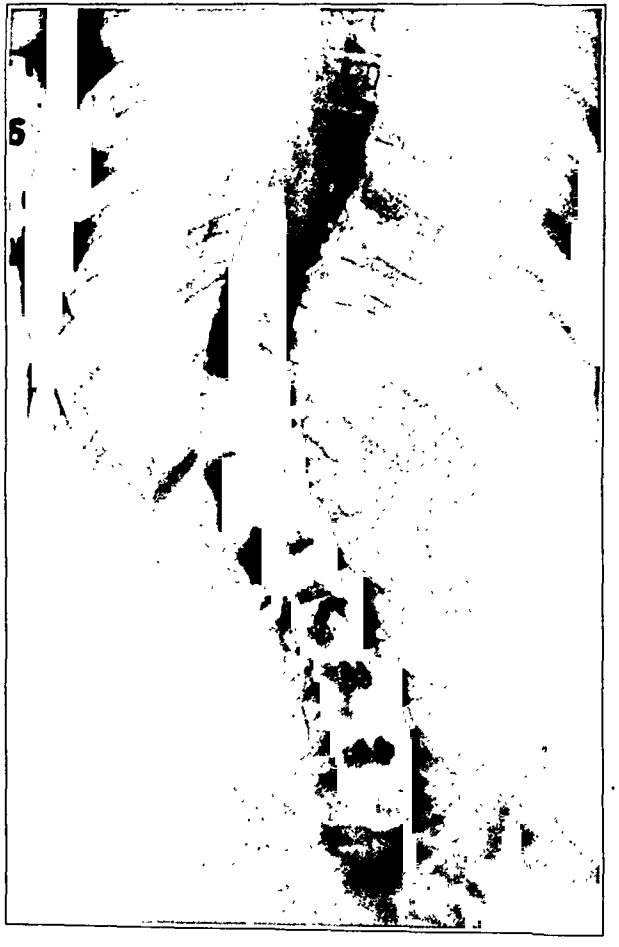


FIG. 24

Case 4. Roentgenogram of patient standing. Before treatment.

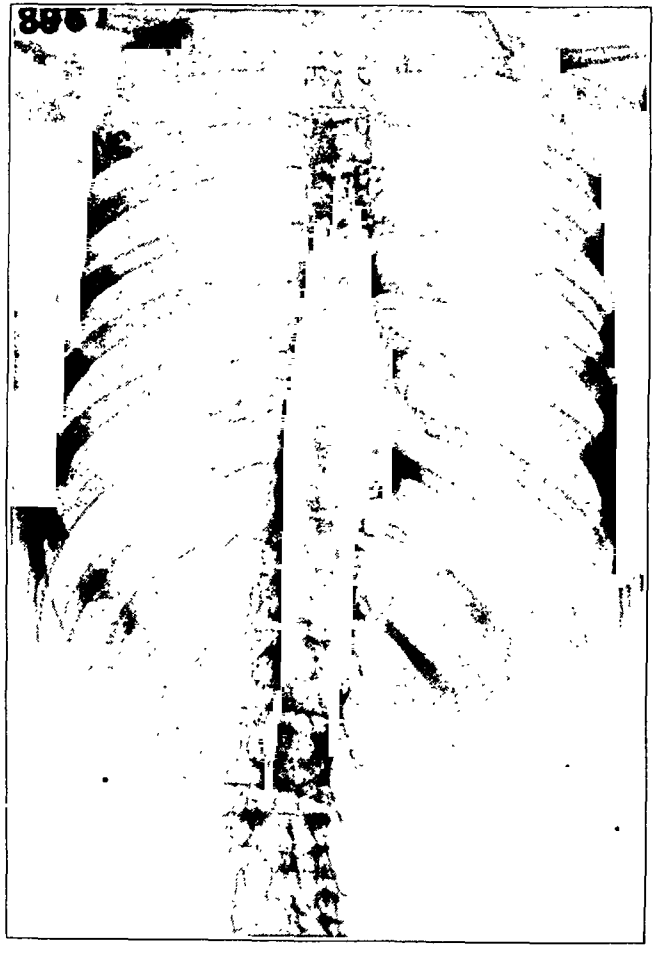


FIG. 25

Case 4. Roentgenogram three years after correction and spine fusion.

TABLE I

RESULTS IN 257 CASES TREATED BY THE WEDGING JACKET

| | Mild (25 degrees or less) | Moderate (25 to 50 degrees) | Severe (Over 50 degrees) |
|---|---|---|---|
| Number of cases | 14 | 125 | 118 |
| Correction by jacket | 95 per cent. | 69 per cent. | 50 per cent. |
| Correction maintained | 80 per cent. | 49 per cent. | 30 per cent. |
| Body balance before operation | Good | Fair | Poor |
| Body balance after operation | Excellent | Excellent | Good |
| Length of fusion area | 8 vertebrae | 9 vertebrae | 10 vertebrae |

loss of correction in the fused area of the spine. Especially in marked curves which have been straightened a good deal, a loss up to 10 degrees may be expected before the new bone is mature. Loss of correction greater than this or any loss localized at one point with widening of the intervetebral space suggests that the fusion is not complete there. In order to detect such changes, an accurate method of measuring the curve, such as that described by Ferguson, should be used. As soon as a pseudarthrosis has been detected, repair should be advised, in order to prevent further loss of correction.

Pseudarthrosis occurred in the fusion area in sixty-one cases or 23 per cent. of the 265 patients treated by the wedging jacket. Of these, forty-seven patients were operated upon again and the defect was repaired. In fourteen cases the diagnosis was made by roentgenographic examination only. Several of these patients declined operation, and the remainder did not require it because there were no symptoms and very little loss of correction. The average loss of correction in patients having a pseudarthrosis was 28 per cent. of the original measurement as compared with a loss of 20 per cent. for all patients. The pseudarthrosis occurred in the thoracolumbar region in thirty-six of the sixty-one cases, indicating that particular care must be taken to produce a strong fusion in this area. In some of the operations we now are reinforcing the mass of chips from the laminae and the spinous processes with small pieces from the tibia.

TABLE II

COMPOSITE ESTIMATE OF RESULTS IN 257 CASES TREATED BY THE WEDGING JACKET

| | Mild (25 degrees or less) | Moderate (25 to 50 degrees) | Severe (Over 50 degrees) | Total Percentage |
|---|---|---|---|---|
| Excellent | 9 | 87 | 36 | 51.3 |
| Good | 3 | 23 | 47 | 28 4 |
| Fair | 2 | 13 | 25 | 15 6 |
| Poor | 0 | 2 | 10 | 4 7 |
| Total | 14 | 125 | 118 | 100 0 |

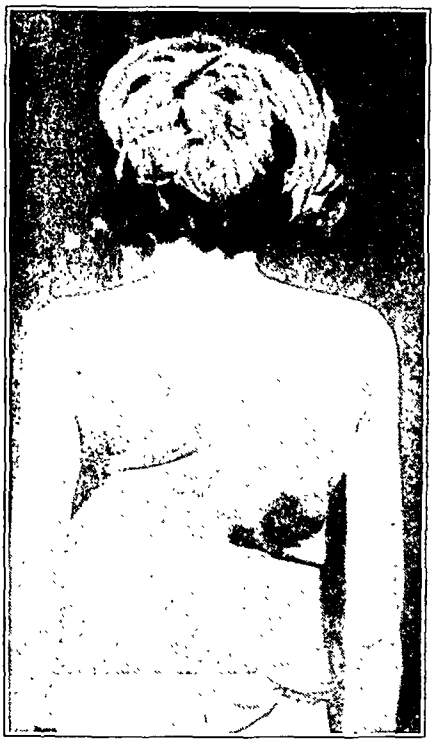


FIG. 26

Case 5. Patient, aged thirteen years, with severe right thoracic scoliosis. Before treatment.



FIG. 27

Case 5. Two years after partial correction and spine fusion. Note improvement in body balance.

During the years 1928 to 1935, inclusive, 301 patients had spine-fusion operations for scoliosis. Fourteen had operations to extend previously fused areas. Twenty-two were operated on after treatment in the old traction jacket or without any attempt at correction. In the remaining 265, the deformity was corrected in a wedging jacket before operation. The causes of the deformity were: poliomyelitis in eighty-six cases; congenital malformations in eleven cases; polio-encephalitis, rickets (possibly), empyema, Friedreich's ataxia, muscular dystrophy, spastic paralysis, and syringomyelia in one case each; and idiopathic or unknown in 197 cases. There were 213 females and eighty-eight males. The ages of the patients varied from two to forty-four years, with an average of thirteen and four-tenths years. There were two deaths ascribable to operation, or an average of 0.66 per cent. Since there was an average of two operations per patient, approximately 600 operations were performed, and the percentage for operations was 0.33. The patients were observed from one to ten years after operation, with an average follow-up period of four and four-tenths years.

For the purpose of estimating the results of treatment, the patients have been divided into groups according to the severity of their deformities. The first group consists of patients with mild curves of 25 degrees or less; the second, of patients with moderately severe curves of from 25 to 50 degrees; and the third, of those with severe curves of more than 50 de-

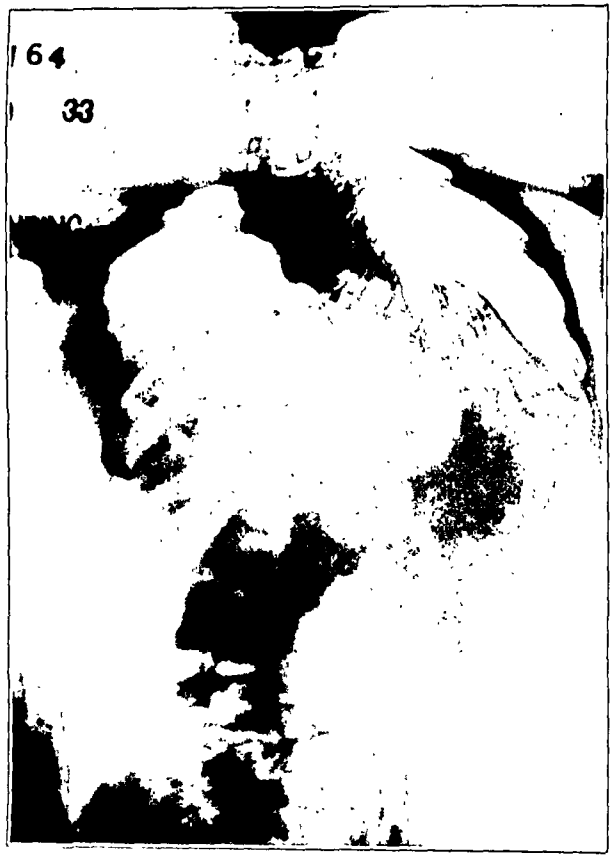



FIG. 28

Case 5. Roentgenogram of patient standing. Before operation.



FIG. 29

Case 5. Roentgenogram of patient standing. Two years after operation. Note improvement in compensation.

## COMMENT

Ollier's disease is a term which has been used to denote certain asymmetrical cartilaginous dystrophies of characteristic appearance and distribution, best revealed by the roentgenogram. Roentgenographically, there may be confusion with some cases of osteitis fibrosa cystica, of either generalized or focal type. Xanthomatosis may also present some difficulty in differential diagnosis, but may be identified by biopsy. (Studies of xanthomatosis will be reported later.)

The involvement in the case reported is both symmetrical (legs) and asymmetrical (arms) and clearly demonstrates that symmetry is of no diagnostic import. The disease consists of cartilaginous lesions, which tend to become grouped, first, in individual long bones, and, second, in extremities. The reason for this is not clear as the etiology is unknown. Where more than one extremity is involved, the tendency to affect whole extremities naturally results in either symmetry or asymmetry. In a search of the literature, unfortunately, symmetrical cases have been discarded as not belonging to this group, so that any attempt at statistical conclusions on distribution is misleading.

The disease runs a characteristic course and reaches a stage where the ends of some of the long bones become expanded, grossly deformed, and shortened. In the case reported, the deformity became evident at the third year, but did not become prominent until later. There was a gradual steady increase in the extent of the individual lesions, as well as some spread in their distribution.

There is at no time in the course of this disease a stage where it resembles multiple cartilaginous exostoses, called also "hereditary deforming chondrodysplasia". The nomenclature is confused, since the term "hereditary chondrodysplasia" is also used to describe those cases where there are associated multiple exostoses. "Achondroplasia", in which there is deficiency in the processes of length growth of the long bones, is also frequently called "dyschondroplasia".

Differentiating Ollier's disease on the basis of asymmetrical distribution adds to the confusion. It would seem much more logical to group all the endochondral cases under the term "Ollier's disease", or possibly "endochondrodysplasia". Those associated with exostoses or ecchondral cases, could then be termed "ecchondrodysplasia". This would be particularly permissible, since in one of Ollier's "asymmetrical" cases there was a crossed distribution, one leg and the opposite arm being affected.

The calcium balance in the case reported was strictly within normal limits, thus further differentiating the condition from osteitis fibrosa cystica, which it resembles slightly. This would indicate that if any enlarged parathyroid glands are found in such cases they are due to secondary hyperplasia and should not be removed.

Treatment at the present time is largely that of corrective ortho-

# CORRECTION OF EXTREME FLEXION CONTRACTURE OF THE KNEE JOINT *

BY S. L. HAAS, M.D., SAN FRANCISCO, CALIFORNIA

*From the Shriners' Hospitals for Crippled Children*

Flexion contracture at one knee joint can be compensated for within certain limits by the equinus position of the foot, by flexion of the opposite knee joint, or by a tilt of the pelvis and change in the lumbar spine. When the flexion is so severe that the foot cannot be made to contact with the walking surface, then ambulation is impossible without some mechanical aid such as crutches, an extension shoe, a brace, or a prosthesis.

The majority of contractures of the knee joint are due to a congenital or a developmental abnormality, tuberculosis or other infections of the knee joint, paralysis of the quadriceps femoris muscle, spastic contractures, injuries or inflammation of muscles, burns of the extremity, fractures into the knee joint, dislocations at the knee joint, and injury to the epiphyseal-cartilage plate.

The contractures may be confined entirely to soft parts and joint capsules or there may be, in addition, a destruction of the articular cartilage with fibrous or osseous union between the tibia and the femur.

The method of correction of the deformity varies with the degree and type of contracture. One may be called upon to utilize several procedures in order to obtain correction of the extreme type. It is usually necessary to lengthen or to sever the contracted tendons as well as the posterior capsule of the joint. If there is a bony ankylosis, a wedge resection or a circular resection is necessary before extension can be started. After the tissues are freed, extension may be obtained in a number of ways,—namely, by simple skin traction, by plaster casts with wedging, by hinged plaster casts with turnbuckles, by skeletal traction, by a plaster spica with skeletal traction, or by mechanical devices to produce gradual extension. In the extreme contractures, a considerable hazard exists because of the possibility of injuring the nerves and the blood vessels in the popliteal space. The nerves and blood vessels may be displaced from their normal positions or embedded in scar tissue, making their identification difficult and increasing the possibility of direct injury. Furthermore, during the correction of the deformity, the vessels may be ruptured or thrombosed, resulting in gangrene; or the nerves may be excessively stretched, causing paralysis. In deformities secondary to infection, there is the possibility of stirring up a latent infection.

One must keep in mind the anatomy of the knee joint and the method of movement of the femur on the tibia. We know that the

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 17, 1938.

grees. As will be seen in Table I, by far the greater number were in the second and third groups. As would be expected, the degree of correction was proportionate to the severity of the curve. This has been expressed in percentage of the original deformity rather than in degrees and was 95 per cent. for the mild curves, 69 per cent. for the moderate curves, and 50 per cent. for the severe curves. The correction maintained was 80 per cent. of the original measurement in the mild cases, 49 per cent. in the moderate cases, and 30 per cent. in the severe cases.

As has been pointed out, however, a more important criterion is the improvement in body balance resulting from the treatment. This was changed from an average of good to that of excellent in the mild cases, from fair to excellent in the moderate cases, and from poor to good in the severe cases. It is thus possible to effect a very worth-while improvement in a patient with a curve of 100 degrees with an actual correction to only 80 degrees in the primary curve itself.

Two curves were fused in each of six patients: one had an excellent result; three had good results; and two had fair. Two patients died. The results in the remaining 257 cases are summarized in Table II. In this estimate the degree of correction, body balance, and presence or absence of pain or fatigue were considered. The result was excellent or good in 79.7 per cent., fair in 15.6 per cent., and poor in 4.7 per cent.

## SUMMARY

1. From 1928 to 1935, inclusive, 301 patients were operated on for scoliosis at the New York Orthopaedic Dispensary and Hospital. Of these, 265 had had previous correction of the deformity in the wedging jacket.

2. The results of this treatment were excellent or good in 79.7 per cent., fair in 15.6 per cent., and poor in 4.7 per cent.

## CONCLUSIONS

1. The wedging jacket is the most effective means yet devised for correcting a lateral curvature of the spine.

2. Spine fusion will maintain practically all of the correction thus obtained.

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3. Hibbs, R. A.; Risser, J. C.; and Ferguson, A. B.: Scoliosis Treated by the Fusion Operation. An End-Result Study of Three Hundred and Sixty Cases. J. Bone and Joint Surg., XIII, 91, Jan. 1931.
4. Risser, J. C., and Ferguson, A. B.: Scoliosis: Its Prognosis. J. Bone and Joint Surg., XVIII, 667, July 1936.

patient gave a history of a fall at the age of three, followed by an infection of the tibia and fibula for which several operations had been performed.

*Examination*

The knee was ankylosed in a position of from 20 to 25 degrees beyond the right-angle position (Fig. 1). There were scars over the lower end of the femur and along the anterior surface of the leg. It was difficult to measure the extremity, but there was shortening of about four inches distributed equally in the tibia and the femur. The roentgenogram (Fig. 2) shows the bone deformity which is greatest near the knee joint, as the weight of the leg produced a bowing at the epiphyseal plate.

*First Operation—November 5, 1930*

Lengthening of the hamstrings through a Z incision in the popliteal space was done at this time. Through two incisions on either side of the knee joint, an osteotome was driven in a semicircular manner into the bone in what appeared to be the plane of the joint. It was possible immediately to extend the knee about 40 degrees and, after this had been done, a plaster cast was applied to maintain correction. Good healing took place. Several wedgings of the cast were instituted. Then the Hoke worm-gear knee apparatus was applied, and further correction was obtained to within about 30 degrees of normal. A plaster cast was applied to prevent any recurrence of the deformity and to permit consolidation of the osteotomized bone. An interval was allowed for healing of the incision before the next step of the treatment was begun.

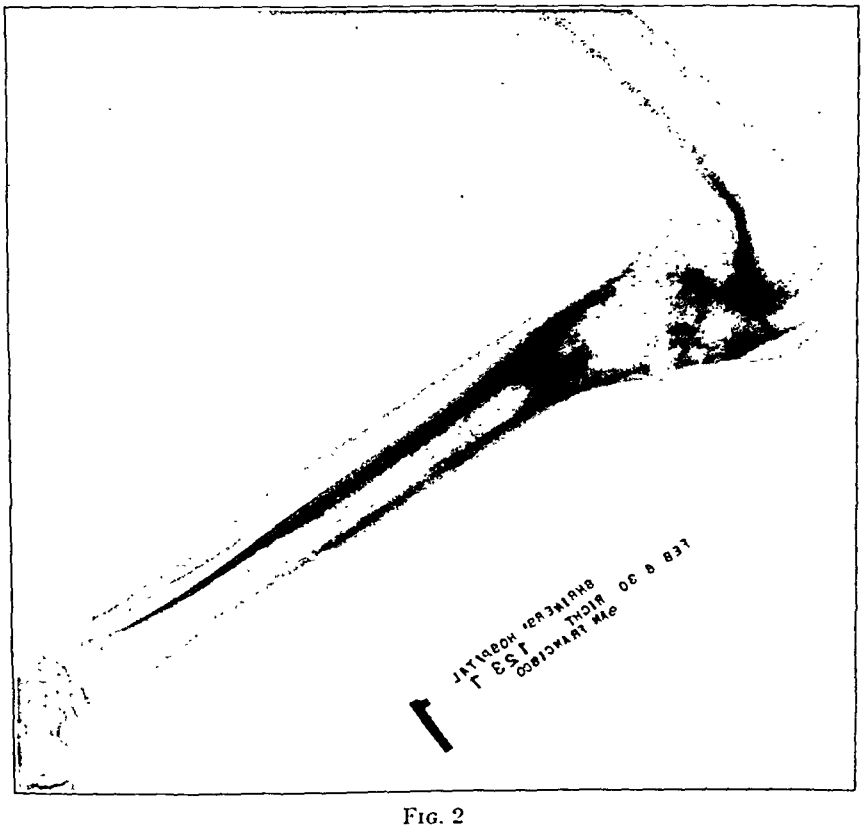


FIG. 2

Case 1. Roentgenogram showing the degree of deformity and the bowing at the epiphyseal plate.



FIG. 1

Case 1. Flexion contracture of the knee of ten years' duration. Note that the contracture at the knee joint is greater than that at the foot because there is bowing of the tibia at the epiphyseal plate, due to the weight of the foot.

motion at the knee joint does not take place as a simple hinge joint, but that there is a gliding motion of the femur on the tibia. Since the medial condyle of the femur is longer than the lateral condyle, a certain amount of rotation must take place in the tibia during extension. There is also a tendency toward valgus deformity, due to the pull of the biceps and of the prolongation of the tensor fasciae latae on the tibia. In the long-standing contractures without ankylosis, a flattening of the curve of the articular surfaces may be caused by pressure. The menisci will undergo irregular pressure atrophy, and the cruciate ligaments, particularly the posterior, will become contracted. In growing children there is a tendency toward increased growth on the anterior or convex side of the curve, due to a decrease in pressure, and hindrance of growth along the concave side, due to increase in pressure. This abnormal distribution of growth tends toward subluxation and recurrence of the contracture in the growing child.

One of the difficult problems is the prevention of posterior subluxation or the correction of the already existing subluxation during the extension of the contracted knee joint. In order to prevent or to correct luxation, there must be an anterior thrust on the tibia at the same time that the extension force is applied. In the case of the hinged plaster cast, this can be obtained by planing the axis of the hinge anterior to the axis of the knee joint or by providing a sliding joint which allows the lower segment to extend and to go forward. Skeletal traction on the tibia, or on the tibia and the os calcis, with a pull anteriorly to the fixed femur, is a satisfactory method provided there are no contra-indications to the insertion of a pin. Skeletal traction is rarely necessary, and its promiscuous use only adds another possibility of infection.

In this series of four severe contractures of the knee joint, one was of the congenital type, one was secondary to osteomyelitis of the tibia, and two were sequelae to severe burns. The patients were unable to walk without crutches or mechanical aid, and the deformities were unsightly. Correction was instituted in an endeavor to secure a straight, weight-bearing extremity and to conserve the extremity.

## CASE REPORTS

CASE 1. D. R., white, female, aged thirteen years and three months, was admitted to the Shriners' Hospital because of a stiff, bent right knee, on October 29, 1930. The

was started. A month later, a new plaster cast with hinges and a turnbuckle was applied on the anterior surface of the knee, and correction was continued for two months.

*Third Operation—March 1, 1935*

The scar tissue, which was very thick, was removed from the popliteal region, and all the tendons were lengthened again and the posterior capsule was sectioned. The skin was closed by means of a zigzag incision. A week later a slight sloughing took place in the skin flaps. Several plaster casts with wedging and turnbuckles were applied during the next few months. (See Figure 8.) On July 2, 1935, a plaster cast with a walking iron was put on the extremity which at this time was almost straight.

On August 31, 1935, fourteen months after treatment was begun, the patient was discharged from the Hospital. She was able to walk fairly well. There was some pull on the hamstrings, but there was no power of extension. She put the main part of her weight on the crossbar of the brace, just below the foot.

On February 4, 1936, the patient was readmitted to the Hospital. She walked fairly well with the brace. There was good hip motion, but no power of extension was present at the knee joint. There was some power of knee flexion, and the ankle was in 45 degrees of equinus without motion. Epicritic sensibility was diminished over the lateral surface of the leg, also protopathic sensibility to a lesser degree. An artificial limb was made, but its fitting was difficult, due to the presence of the foot deformity (Fig. 9). Amputation of the foot was not desired. The patient was discharged from the Hospital on May 5, 1936.



FIG. 9

Case 2. Photograph showing the prosthesis. Notice the toes projecting above the artificial foot.

*Last Examination—June 17, 1937*

One year later there was a little flexion at the knee joint: active flexion, 15 degrees; passive flexion, 30 degrees. The patient had some power of flexion of the toes, of supination of the foot, and of contraction of the gastrocnemius. There was a loss of sensation from above the knee and down the inner side of the leg. The patient walks quite well. If the foot were amputated, it would be easier to fit a prosthesis.

CASE 3. E. J., colored, male, aged nine years, was admitted to the Shriners' Hospital on April 2, 1936, because of contraction of the right knee, following severe burns of the legs at the age of six. At the Berkeley General Hospital, skin grafts had been applied to both legs, but those on the right had not been successful. After leaving the Hospital the patient had received nothing but ultra-violet-ray therapy. The right leg had gradually become contracted at the knee until the heel was opposite the buttocks.

*Examination*

The patient was able to walk only with crutches. The right leg was in extreme flexion contracture, the calf being symbiosed to the thigh (Fig. 10). In spite of the long period of about three years of fixed flexion, there were still a few degrees of motion in the knee joint and a definite pull in the quadriceps and hamstring muscles. There were no disturbances in sensation along the lower part of the leg and foot. Some flexion contracture was noted. Motion in the ankle and tarsal joints was normal. There was only a small patch of skin just below the knee joint. Over the knee joint and extending about one-fourth the length of the thigh was a granulating surface which merged into the granulation tissues on the posterior surface of the leg, thus forming a union between the



FIG. 6

Case 2. Flexion contracture at the knee joint, beginning at birth. The patient walked with an artificial limb with weight-bearing on the flexed knee.

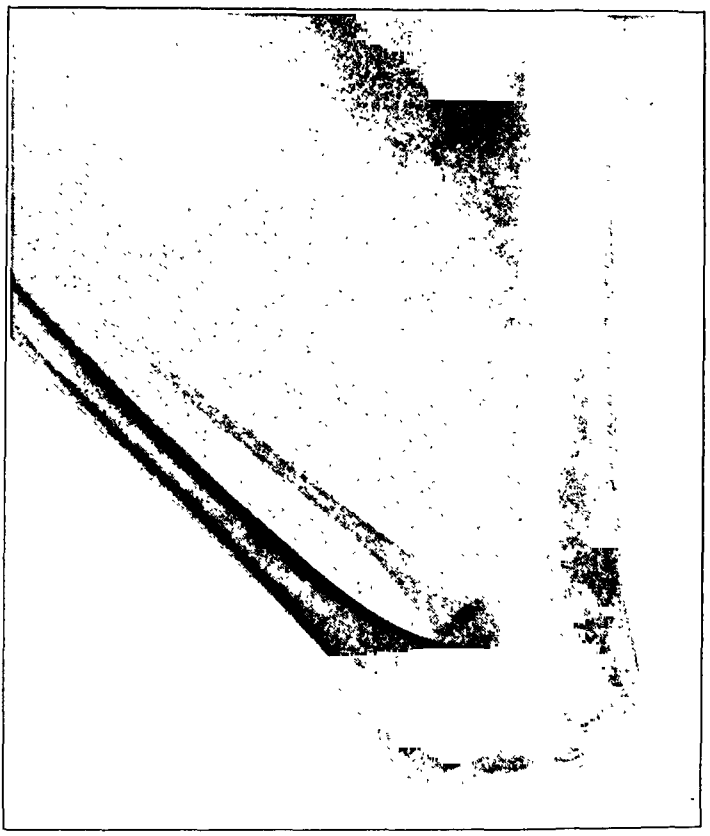


FIG. 7

Case 2. Roentgenogram showing extreme flexion at the knee joint. The patella is absent.



FIG. 8

Case 2. Lateral roentgenogram, showing the extremity in plaster being wedged out to within 45 degrees of full extension. There is no luxation of the tibia.

calf and the posterior part of the thigh. There was an extension of the granulating surface on the posterior aspect of the thigh almost up to the buttocks and downward circularly about the leg for about two-thirds of the distance to the ankle joint. (See Figure 11.) It is remarkable that this granulating tissue, which had been present for three years, was dry and glossy without any weeping, and no dressing was used by the patient. Figure 12 shows the contracture, the luxation of the tibia with the overgrowth of femur, and the patella in contact with the articulating surface of the condyle. On account of the long duration of the contracture (about three years) and the presence of granulation tissue, it was realized that any attempt to correct the deformity involved considerable danger of circulatory and nerve disturbance, as well as of infection, with possible loss of the extremity. This was explained to the parents before treatment was instituted.

*First Operation—April 8, 1936*

This operation consisted in partial release of the contracture and skin grafting. The web between the calf and the thigh was incised, and dissection was carried across this area from both sides. The contracted tendons were lengthened in Z fashion. The tibial nerve with its branches to the gastrocnemius and the small sciatic nerve were exposed during the operation. The popliteal artery pulsated at the base of the wound. It was possible at this time to extend the leg about 40 degrees. The denuded popliteal area was covered with split skin grafts removed from the opposite thigh. A normal saline dressing was put over the grafted area, and a plaster-of-Paris cast was applied from the toes to the groin. The greater part of the grafts remained permanently viable.

*Second Operation—April 22, 1936*

A considerable part of the remaining granulating area was covered with split skin grafts and Thiersch grafts which were removed from the abdomen.

*Third Operation—May 15, 1936*

The remaining portion of the granulating surface was covered with split skin grafts. After healing had taken place, a modified Russell type of traction was applied to the extremity, and the patient was placed on a Whitman frame to correct the flexion contracture of the hip. One of the main problems was to correct the existing posterior luxation at the knee joint. Various types of plaster casts with hinges and turnbuckles were applied. On one type, an adjustable hinge to allow traction in extension was utilized and, in addition, a turnbuckle was placed anteriorly to pull the leg forward to help correct the luxation of the tibia. After completion of this procedure, correction was obtained to within 15 degrees of full extension of the knee joint. (See Figures 14 and 15.) Because of the fact that healing had been delayed for three years, skeletal traction was not utilized, as it was thought there was too great a chance of infection of the tibia. It was impossible to correct the subluxation, so there was a marked prominence of the lower end of the femur and patella at the completion of



FIG. 14



FIG. 15

Case 3. Lateral and anterior views of patient on discharge.



FIG. 6

Case 2. Flexion contracture at the knee joint, beginning at birth. The patient walked with an artificial limb with weight-bearing on the flexed knee.



FIG. 7

Case 2. Roentgenogram showing extreme flexion at the knee joint. The patella is absent.



FIG. 8

Case 2. Lateral roentgenogram, showing the extremity in plaster being wedged out to within 45 degrees of full extension. There is no luxation of the tibia.

paedics. Fractures and deformities are frequent. While there have not been many reports of cases followed through adult life, the prognosis is apparently good.

Since these cases are rare (Cleveland in 1928 reported in the literature only fifteen asymmetrical cases of Ollier's disease), only very tentative conclusions can be drawn from our present knowledge. It is important that further cases be reported in an effort to establish the nature of this condition and its relation to the various other cartilaginous and osseous dystrophies.

NOTE: Since this study was made, a rather extensive discussion of a similar nature has been reported by Mahorner.

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FIG. 10

Case 3. The calf of the leg is symbiosed to the thigh. Note the ulceration still present three years after the original injury from burns.



FIG. 11

Case 3. Close-up view, showing ulcerations which had been present for three years, but no dressing was required by the patient.

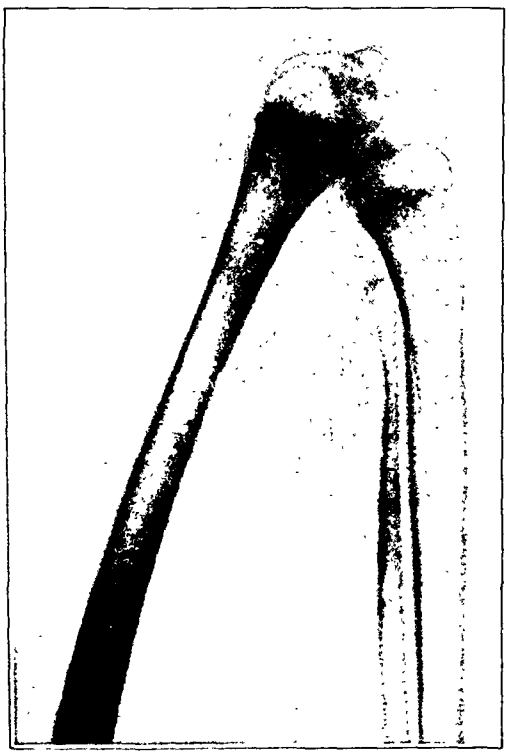


FIG. 12

Case 3. Roentgenogram showing the overgrowth of the femur with luxation of the tibia and the patella.

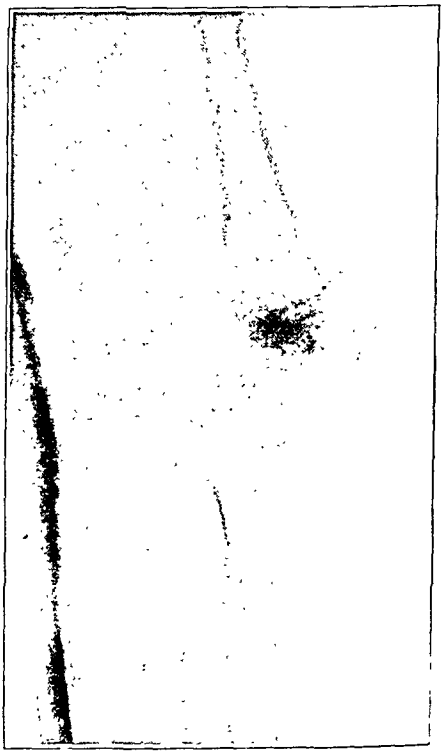


FIG. 13

Case 3. Roentgenogram, taken March 25, 1938, showing result.

calf and the posterior part of the thigh. There was an extension of the granulating surface on the posterior aspect of the thigh almost up to the buttocks and downward circularly about the leg for about two-thirds of the distance to the ankle joint. (See Figure 11.) It is remarkable that this granulating tissue, which had been present for three years, was dry and glossy without any weeping, and no dressing was used by the patient. Figure 12 shows the contracture, the luxation of the tibia with the overgrowth of femur, and the patella in contact with the articulating surface of the condyle. On account of the long duration of the contracture (about three years) and the presence of granulation tissue, it was realized that any attempt to correct the deformity involved considerable danger of circulatory and nerve disturbance, as well as of infection, with possible loss of the extremity. This was explained to the parents before treatment was instituted.

*First Operation—April 8, 1936*

This operation consisted in partial release of the contracture and skin grafting. The web between the calf and the thigh was incised, and dissection was carried across this area from both sides. The contracted tendons were lengthened in Z fashion. The tibial nerve with its branches to the gastrocnemius and the small sciatic nerve were exposed during the operation. The popliteal artery pulsated at the base of the wound. It was possible at this time to extend the leg about 40 degrees. The denuded popliteal area was covered with split skin grafts removed from the opposite thigh. A normal saline dressing was put over the grafted area, and a plaster-of-Paris cast was applied from the toes to the groin. The greater part of the grafts remained permanently viable.

*Second Operation—April 22, 1936*

A considerable part of the remaining granulating area was covered with split skin grafts and Thiersch grafts which were removed from the abdomen.

*Third Operation—May 15, 1936*

The remaining portion of the granulating surface was covered with split skin grafts. After healing had taken place, a modified Russell type of traction was applied to the extremity, and the patient was placed on a Whitman frame to correct the flexion contracture of the hip. One of the main problems was to correct the existing posterior luxation at the knee joint. Various types of plaster casts with hinges and turnbuckles were applied. On one type, an adjustable hinge to allow traction in extension was utilized and, in addition, a turnbuckle was placed anteriorly to pull the leg forward to help correct the luxation of the tibia. After completion of this procedure, correction was obtained to within 15 degrees of full extension of the knee joint. (See Figures 14 and 15.) Because of the fact that healing had been delayed for three years, skeletal traction was not utilized, as it was thought there was too great a chance of infection of the tibia. It was impossible to correct the subluxation, so there was a marked prominence of the lower end of the femur and patella at the completion of



FIG. 14



FIG. 15

Case 3. Lateral and anterior views of patient on discharge.



FIG. 16

Case 4. Patient nine months after burn on the right extremity, showing circular ulceration about the knee with the upper calf united to the lower thigh. Notice the marked flexion contracture of the hip and the heavy scar bands across the groin.

the correction of the deformity. The patient could flex the knee about 10 degrees, and about 5 degrees more motion could be obtained passively. He was dismissed wearing a long leg brace for protection. Subsequent follow-up examinations in clinics showed occasional ulceration, but, in general, the condition remained about the same. Further treatment was instituted on March 23, 1938, to complete the correction and to obtain more motion (Fig. 13).

CASE 4. R. W., white, male, aged five years, was admitted to the Shriners' Hospital, October 22, 1936, because of contractures of the right hip and knee, following severe burns on both legs and abdomen received in December 1935. He had been taken to a local county hospital and, at the end of three weeks the physician reported there was no chance for his recovery. He was, therefore, taken home where he subsequently recovered, but severe contractures of the knee and hip joints developed. The boy received no treatment until he was brought to the Shriners' Hospital about nine months later.

*Examination*

The patient had a marked flexion contracture at the right knee joint of about 160 degrees. The upper part of the calf was joined to the lower part of the thigh. There was a complete circular ulcer extending around the leg and thigh. Some normal skin was present over the anterior part of the knee and lower thigh. The hip was in about 90 degrees of flexion contracture with heavy, scar-contracting webs extending from the abdomen to the thigh (Fig. 16). There was some evidence of nerve involvement as shown by the very weak hamstring and the tibialis anterior muscles; most of the muscles were below normal strength.

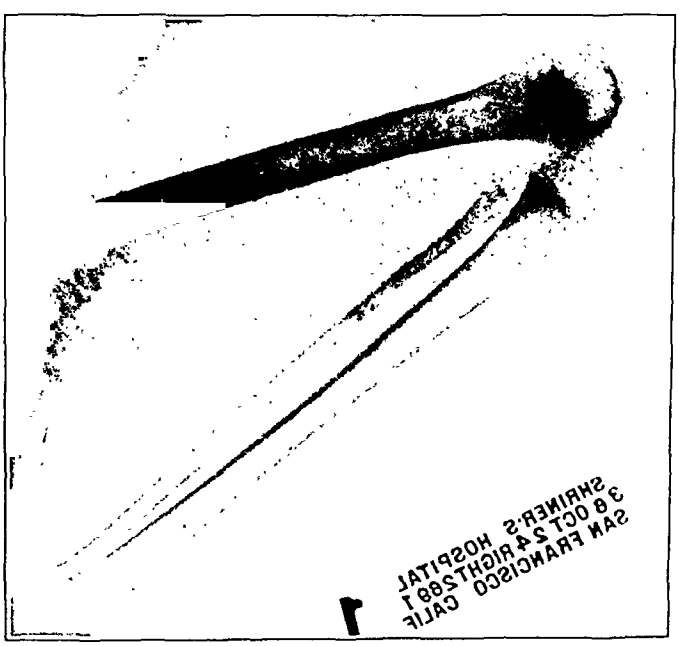



FIG. 17

Case 4. Roentgenogram showing the marked flexion with subluxation of the tibia on the femur. The patella is pulled down on the condyle.

The roentgenogram (Fig. 17) shows the contracture at the knee joint, disuse atrophy of the bones, and the relative position of the femur and the tibia.



FIG. 18

Case 4. Roentgenogram showing almost full extension at the knee joint. There is some posterior luxation of the tibia.



FIG. 19

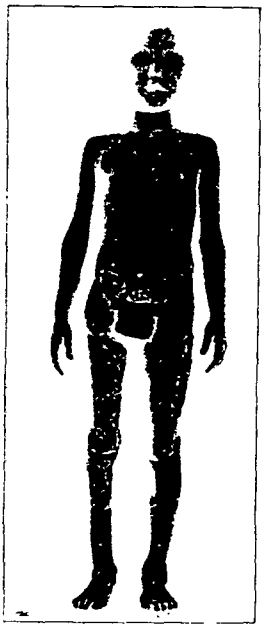


FIG. 20

Case 4. Lateral and anterior views showing the correction obtained. The flexion contracture of the hip has also been corrected by operation.

*First Operation—October 28, 1936*

An incision was made between the juncture of the granulating area of the calf with the posterior surface of the thigh. All of the hamstrings were lengthened by a Z incision. The dissection was then carried down to the popliteal space. The peroneus communis nerve, which was exposed, was later surrounded with a fat graft. At the end of the operation the denuded area in the popliteal space was covered by split skin grafts removed from the left thigh, and a considerable portion of the remaining ulcerated areas was treated with Thiersch grafts. The leg was brought out almost to the position of 90 degrees of flexion.

*Second Operation—February 12, 1937*

The heavy, dense scar in the inguinal region was excised, after which a series of flaps of skin in zigzag form were shifted to fill in part of the gap. A considerable defect on the inner side of the thigh was filled in by a full-thickness graft removed from the lateral abdominal region. Gauze was wet with saline solution, and with sea-sponge pressure was put on the operated area, and a plaster spica was applied to keep the extremity at rest. Subsequent treatment consisted of plaster casts to correct the foot flexion and remaining knee flexion. The patient was kept on a Whitman frame to stretch the flexion contracture at the hip. He was discharged from the Hospital with a long caliper brace on May 24, 1937, about seven months from the time of admission.

*Last Examination—August 12, 1937*

Examination at this time showed full correction of the knee contracture with slight subluxation of the tibia (Fig. 18) and a small amount of contracture at the hip joint (Figs. 19 and 20). There was still considerable weakness of the muscles of the foot. Some lengthening of the right tibia was noted. The patient was able to flex the knee 90 degrees, with fairly good power of extension from that position.

## CONCLUSIONS

Extreme flexion contracture of the knee joint is a very disabling deformity, but it is amenable to operative correction. Care must be taken not to injure the nerves and blood vessels either by operation, by too rapid correction, or by rough manipulative methods. Skeletal traction is a useful adjunct, but its promiscuous use is to be deplored, especially when there is the possibility of infection.

# SCIATIC PAIN OF UNKNOWN ORIGIN

## An Effective Method of Treatment *

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Sciatic pain may be classified as of unknown origin when, after an exhaustive clinical study, no cause can be found. A general medical examination, including comprehensive laboratory studies, is the initial step to rule out such systemic causes as diabetes, perineuritis from metallic poisoning, and pain due to intrapelvic or intra-abdominal pathology. Thereafter orthopaedic and neurosurgical consultations, together with lumbar puncture and manometric readings, follow. Possible foci of infection are carefully investigated. The examination is concluded by roentgenograms of the lower spine and the pelvis, which comprise true anteroposterior, lateral, and 45-degree-angle views; and in this group these are supplemented by additional lateral views of the lumbosacral spine in the position of maximum flexion and extension. If these various studies fail to determine the etiology, then the sciatic pain is classified as of unknown origin.

It is the purpose of this paper to present a method of treatment for sciatic pain, which has been successfully employed where the etiology of the sciatica is not known. The method is also applicable for immediate relief of severe sciatic pain while a clinical study is being made to determine the cause. This report is based upon the results obtained in a group of seventy-five patients with sciatica of unknown origin, who were seen in the four-year period ending January 1, 1937, and who represent 5 per cent. of all patients examined in this interval, with sciatic pain as a predominant complaint. In the complex therapeutic problems presented by the sciatic syndrome, it is well recognized that no single method of treatment will at all times suffice. It is also true that in a certain number of patients (in this group, 50 per cent.) symptoms or signs later develop, which make it possible to allocate the source of their complaint to one or more etiological factors. However, in those individuals in whom no cause for the sciatic pain is found, or in whom the etiology is not clear at the time of the first and immediately subsequent examinations, it is none the less desirable to attempt relief of pain which is often severe. With the therapy here described we have had greater success than with any other method.

In the type of case under discussion, as well as in cases of sciatica which accompany demonstrable disorders of the lower back, the exact

* Read at the Annual Meeting of the American Orthopaedic Association, Atlantic City, New Jersey, May 4, 1938

origin of the pain is not clearly understood because of the lack of pathological information. A true neuritis of the sciatic nerve is not considered here, as in none of these individuals did neurological examination show evidence of such pathology.

That sciatic pain is in part a referred pain has long been recognized, and a typical example is the case in which the symptoms result from pressure over the posterior sacro-iliac ligament (Fig. 1) which causes pain to be referred down the posterior mid-thigh, and in particular to the lateral aspect of the lower leg. From an analysis of the findings in a large series of patients, Badgley concluded that low-back pain with radiation of pain into the leg is a clinical syndrome, arising from a primary lesion located in the lumbar, lumbosacral, or sacro-iliac regions, and is of muscle, joint, or skeletal origin. He further stated that the pain is due to irritation of sensory-nerve endings in this area, and is radiated primarily by a reflex mechanism which is typically postaxial in distribution.

From another angle, Steindler has well demonstrated this reflex character of sciatic pain in his description of the posterior syndrome, by which he refers to the structures supplied through the posterior division of the spinal nerve. Following this author's suggestions, the writer has likewise been able to exhibit localized areas of tenderness or "trigger points" in cases of posterior musculo-aponeurotic or ligamentous involvement. These tender points are the source of afferent impulses which initiate the reflex discharge of pain. The leg signs—that is, sciatica—were especially well shown in lesions of the deeper ligamentous structures of the lumbosacral junction, of the iliolumbar ligaments, and in cases of sacralization. We have found local injections of novocain of value not only as an aid in diagnostic differentiation as to the source of the symptoms, but also as a therapeutic measure. Kellgren similarly reported satisfactory therapeutic results from local injections of novocain into these tender points. Alcohol injections of these same painful areas, as suggested by Harris, have not been attempted.

An acceptable anatomical basis for the presence of referred pain in patients with pathological conditions of the intervertebral articulations is presented also by Steindler, when he calls attention to the nervus sinuvertebralis described by Purkinje in 1845 and by von Luschka in 1850. This nerve, arising just outside the intervertebral foramina, turns back into the intervertebral canal and the nerve endings go to the pedicles, the interiors of the bodies, the loose areolar perimeningeal tissue, and the periosteum.

It is accepted that pathological change in or about the intervertebral foramina is a cause for low-back pain and sciatica. The more common factors which precipitate such symptoms are: arthritis of the spine, unstable facets of the vertebrae, and obvious structural change as seen in cases of spondylolisthesis.

It is also believed that disease of the sacro-iliac joint is a cause of sciatica, and that this sciatic pain is most satisfactorily explained as being

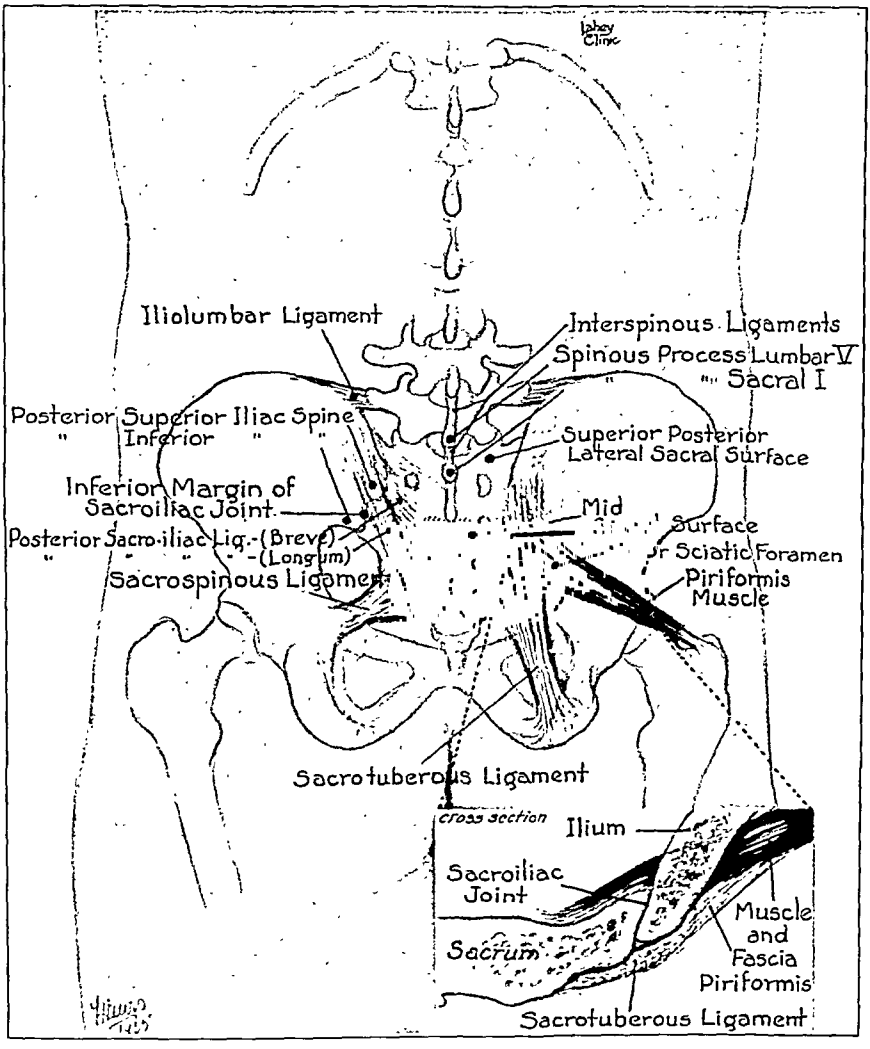



FIG. 1

Illustrating anatomical landmarks in the low-back region with particular reference to the areas palpated for tenderness during clinical examination. The insert depicts the close relationship of the piriformis muscle to the sacro-iliac joint; the latter is enclosed by the muscle and its fascia.

due to spasm and probable congestion of the piriformis muscle (Fig. 1), as described by Freiberg. Although operative division of the tendon of the piriformis muscle has not been done, in eight patients with demonstrable clinical and roentgenographic evidence of sacro-iliac disease with sciatica, novocain injections of the substance of the piriformis muscle and of its fascia have been carried out with marked relief of the sciatic pain. These patients did not respond to purely conservative measures, and all had refused any operative therapy other than the injection.

It is, therefore, believed that sciatica associated with musculoskeletal disorders in the low back is the result of pathological change either in or

about the spine and the intervertebral foramina, or of disease of the sacroiliac joint with its accompanying spasm of the piriformis muscle, or, finally, of myofascitis. The fact that in the present group of cases no definite etiology was originally demonstrated does not rule out the probability of such a causal relationship. As is well known, a patient may have definite sciatica with or without back symptoms, yet the initial examination will not disclose the etiology. In thirty-eight cases of this group it was possible later to demonstrate the cause of the sciatic pain.

Another point of interest in the study of sciatica is that the distribution of pain in the lower extremities is not indicative of the source of pain. This is particularly well borne out by our experience with herniation of the intervertebral discs. In twenty-five such cases proved at operation, the findings repeatedly showed that the distribution of the pain in the lower extremities did not correspond to the nerve root or roots irritated by the herniation. This point is further emphasized by Badgley in a study of 447 patients with low-back pain and sciatica, wherein he stated that the type of skeletal change seen in the roentgenograms bore no definite relationship to the extent and location of radiation of pain, nor was local tenderness more evident over the site of the most marked skeletal changes. It may be, as Kimberley suggests, that irritation of the nerve root lowers its threshold to stimuli, and protopathic sensations are sent out along its motor branches, while the sensory branches within the nerve are also stimulated. If the stimuli are strong enough, they may spill over into other branches of the sciatic nerve, resulting in a wide distribution of the pain in the lower extremities.

In the treatment of patients with sciatica, it has been our policy to mobilize them as rapidly as possible and, consequently, the general line of treatment has been directed toward mobilization, as opposed to immobilization. Many authors have reported excellent results with the use of plaster casts and long rest in bed, but in our hands, with the exception of cases of degenerative arthritis of the spine, the results from this treatment have not been encouraging. It is true that the sciatica is often relieved, but then the patients experience a relatively prolonged period of disability before again returning to a reasonably normal status, due to pronounced stiffness and muscle atrophy. Another method of therapy which has enjoyed wide vogue is that of saline or preferably novocain-saline injection into the epidural space by way of the sacrococcygeal foramen, originally described by Sicard in 1901. In our hands this procedure has been disappointing and has consequently been abandoned.

The method of treatment employed in this group of patients is a combination of two, and in some instances of three, procedures: (1) perineural injection of the sciatic nerve with novocain (1-per-cent. solution); (2) traction to the affected extremity; and (3) in an increasing number of cases manipulation of the low back under intravenous pentothal anaesthesia. Traction for the relief of sciatica has been utilized by many men, but it was the author's impression that perineural injection of the

sciatic nerve had not been so commonly employed. In a recent study of the literature, however, he finds that Wilfred Harris of London reported intramedullary saline injections of the sciatic nerve in 1926. The difference between the two techniques is essentially that in the method used by Harris the actual substance of the sciatic nerve is injected under a moderate amount of pressure, while in the procedure here described, the objective has been to surround the sciatic nerve with the solution and possibly also to inject its sheath. In addition, the fascia and substance of the piriformis muscle, and in some instances the posterior sacro-iliac ligament, are thoroughly infiltrated.

In more recently treated patients, traction to the extremity has been omitted in all but the most resistant cases. It has been found that by a combination of perineural injection and manipulation the sciatic symptoms have been in a large measure controlled, and, consequently, it has been possible to mobilize the patient more rapidly. As will be described later, the manipulations are in no sense drastic, and it is believed that, with the type of manoeuvers carried out, no injury is done to the ligamentous, muscular, or bony structures of the trunk and the pelvis.

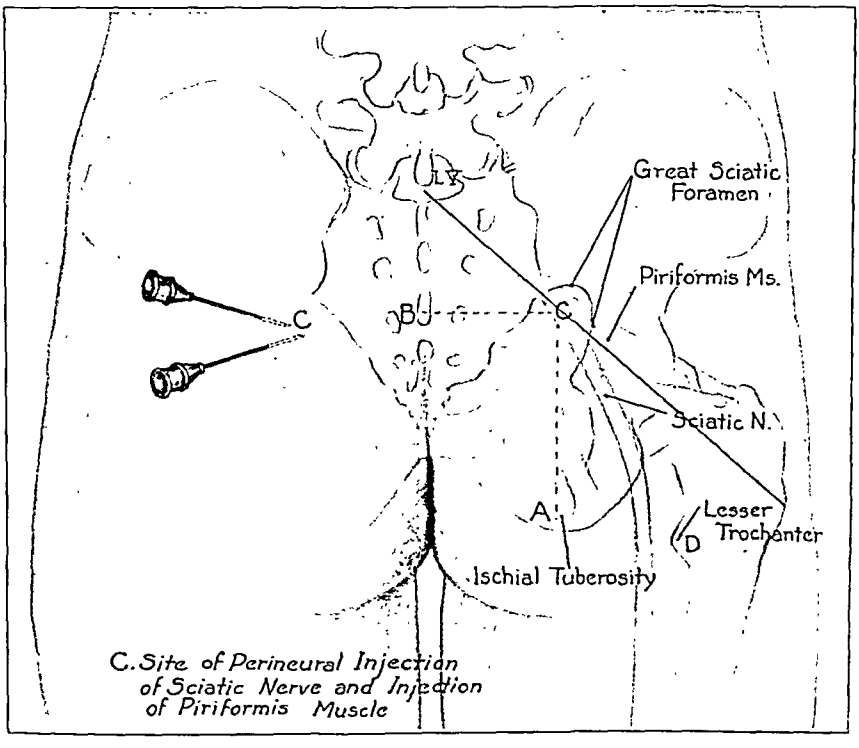



FIG. 2

Technique of perineural injection of the sciatic nerve as it emerges through the greater sciatic foramen. The intersection of the dotted lines and the line drawn from the femoral trochanter to the fifth lumbar spinous process indicates the point at which the needles are introduced.

A solution of 1-per-cent. novocain is now employed rather than a combination of novocain and saline. This regime has been adopted because use of the novocain solution alone has been definitely more efficacious in relieving immediate discomfort and in maintaining freedom from symptoms than has the combination of novocain and saline. The explanation of this is not understood.

The objective of the injection procedure is to reach the perineural area of the sciatic nerve as it emerges from the pelvis through the greater sciatic foramen, as well as to inject the adjacent fascia and substance of the piriformis muscle. The patient is placed in the supine position on the operating table which is so adjusted that the hip joints are flexed approximately 20 degrees. With the buttock of the affected side exposed, the points of insertion of the needle are determined by the intersection of a line projected from three inches (in the male) to three and one-half inches (in the female) directly laterally from, and at the level of, the apex of the intergluteal fold, and an imaginary perpendicular line erected from the ischial tuberosity (Fig. 2). This point is marked on the skin by a small dot of gentian-violet stain. The point of injection is further checked by drawing another imaginary line from the mid-lateral aspect of the greater trochanter to the spinous process of the fifth lumbar vertebra. This line indicates the extreme lateral margin of the injection field. In the average pelvis, this line will intersect the two lines already mentioned at essentially the same point.

The entire field is then prepared with iodine in the usual manner. The skin is anaesthetized over the area identified by the dye, and a 20-gage 6-inch needle is passed in an anteromedial direction from this point at an angle of 45 degrees with the skin surface. Little or no discomfort is experienced until the fascia underlying the mass of the gluteus maximus muscle is encountered. A further injection of novocain may then be necessary. If the needle is in the correct position, as it progresses inward, the patient will shortly experience a transitory lightning-like pain, extending down the posterior mid-line of the lower extremity and corresponding to the general course of the sciatic nerve. This is proof that the needle is in the correct location, and it is then withdrawn about five-tenths of a centimeter. With this needle as the center of a small circle, two other needles are similarly passed inward and downward until the fascia and substance of the piriformis muscle are encountered, which may be recognized by the degree of resistance offered in comparison to that encountered as the needle traverses the mass of the gluteal muscle. It will be noted that all of these needles enter the greater sciatic foramen.

A solution of 1-per-cent. novocain with two drops of 1/1000 adrenalin to the ounce is employed, and an average amount of fifty cubic centimeters is placed immediately about the trunk of the sciatic nerve. Into the remaining two needles an additional total of 100 cubic centimeters of the solution is introduced.

In an occasional instance, the patient may be susceptible to novocain

and, therefore, may have a mild reaction, as exemplified by a rapid pulse, increased rapidity of respiration, and a sensation of faintness. The precaution is always taken to ask the patient if untoward symptoms have been experienced with the previous use of novocain,—for example, in the extraction of a tooth, or in a tonsil operation. If there is any reason to suspect sensitization, ten to fifteen cubic centimeters of the solution of 1-per-cent. novocain is slowly introduced about the nerve, and the remaining injection is carried out with normal saline solution. Although they gave no history of sensitivity to novocain, ten patients were so treated, to determine if the novocain-saline injection was as effective as the novocain solution. In none of these cases were the results as satisfactory as they were after a second injection of novocain. In consequence, we now routinely use the solution of 1-per-cent. novocain.

Following this procedure, if the needles are correctly placed, the sciatic pain will be diminished or absent. If no relief is obtained, the needles have not been correctly placed, and they should be withdrawn and again introduced.

When this operation is completed, the patient is returned to bed, and skin traction is applied to the extremity if the sciatica is of long duration. The Russell method of skin traction has proved to be most satisfactory. Application of adhesive to the entire extremity—that is, from the upper thigh down to just above the ankle—is reserved for those patients who are of the wiry, very muscular type. It is more effective to apply initial maximal traction than it is to apply a small amount and then progressively to increase the weight,—the same principle that has been repeatedly demonstrated in the use of traction in the reduction of fractures of the lower extremity. In the average case, for the first thirty-six hours, an initial pull of from twenty-five to fifty pounds is applied; it is then reduced to a maintenance traction of from ten to fifteen pounds. When employed, the average duration of the traction was two weeks; the maximum, six weeks; and the shortest, five days.

Manipulation procedures were added to our armamentarium with considerable caution some seven years ago. They were first applied to patients with acute low-back pain, with or without sciatica—particularly those with a diagnosis of unstable fifth lumbar vertebra—and to some individuals with what was taken to be acute sacro-iliac sprain. Like many physicians, the writer could not satisfactorily explain the experience of patients with acute low-back symptoms, who, discouraged by their slow progress under accepted orthopaedic measures, went elsewhere for office manipulative therapy, with relatively immediate relief. A study of these methods resulted in a selection of torsion manoeuvers applied to the trunk and pelvis as the most effective and, at the same time, the least traumatic to the patient. In this connection, the author is indebted to the textbook by Bankart. Manipulation of the back is always performed under general anaesthesia, preferably obtained by intravenous injection of pentothal. This anaesthetic gives excellent relaxation for short periods

# A REVIEW OF SYNOVECTOMY*

BY PAUL P. SWETT, M.D., HARTFORD, CONNECTICUT

Synovectomy may be described as an operation for the removal of diseased synovial membrane from a joint which is the seat of an inflammatory reaction. The operation is applicable to any of the joints of the extremities, but its use, perhaps unfortunately, has largely been limited to the knee. The purpose of the operation is to improve the integrity of a joint when there is reason to suppose that the continued presence of synovial inflammatory changes will add to the damage, or when it seems likely that the operation will increase the function of a joint and favorably influence the patient's general health.

The author's original paper demonstrated the feasibility of removing large amounts of synovial tissue, without operative complications or unfortunate later effects, in a series of fifteen synovectomies performed on eight patients with chronic atrophic arthritis. From clinical observation it was evident that the operation was followed by a restoration of the synovial tissue or by the development of a substitute which was functionally satisfactory. No one really knew what happened after the operation until Key made his brilliant report in 1925. He operated upon thirty-five rabbits and in each case removed the entire synovial membrane from the anterior compartment, including the infrapatellar fat pad and a part of the internal semilunar cartilage. He was able to study twenty-four of these joints at varying postoperative periods and he found that the joint was approximately normal after sixty days. The new membrane had a more irregular fibrous groundwork than the original and was deficient in the subsynovial areolar tissue. This study of Key's was so comprehensively carried out and so thoroughly reported as to provide assurance that synovectomy can be done with confidence that restitution of a serviceable membrane will promptly follow.

A great deal of interest in arthritis has been manifested during the past fifteen years and this has been reflected in an enormous output of literature. Unfortunately much still remains to be learned in spite of important advances along many lines. As recently as January 1936 a committee reviewing "The Present Status of The Problem of 'Rheumatism' and Arthritis"[7] examined the American and English literature for 1934, a monumental task involving several hundred separate titles, and gave the following conclusions on etiology and pathogenesis: "From this mass of confusing, sometimes conflicting, data one cannot as yet form any conclusive ideas on the etiology and pathogenesis of the disease. It is obvious that no evidence has been brought forth to change the statement of the American Committee for the Control of Rheumatism, that to date

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 3, 1937.

creased symptoms might develop. As the shoulder descent was greater in women, compression symptoms of the subclavian structures developed in them more frequently. Ochsner accepted this anatomical or developmental anomaly as the soil for the scalenus anterior syndrome: "The fact that symptoms are not, as a rule, manifest until adulthood suggests an additional exciting factor. This we believe is contraction and spasm of the scalenus anticus muscle, which results from irritation and stimulation of the brachial plexus, some of the fibers of which supply the scaleni muscles. This produces an abnormal elevation of the first dorsal rib which in turn causes greater irritation and stimulation of the brachial plexus, establishing a vicious circle. . . . This compression [brachial plexus and subclavian artery between the scalenus anterior muscle and the first rib] may be due to stretching of these structures by an abnormally low position of the shoulder, to high fixation of the sternum and ribs (Todd), to low origin of the brachial plexus (Jones), and to spasm of the scaleni muscles, resulting from brachial plexus irritation. Undoubtedly, many if not all of these factors are responsible in the majority of instances." Ochsner sectioned the scalenus anterior muscle through its tendinous area just above its insertion into the first rib, with almost spectacular relief of symptoms. Ochsner's differential diagnosis of scalenus anterior syndrome considered cervical rib, subacromial bursitis, supraspinatus-tendon rupture, cervicothoracic sympathalgia, Raynaud's disease, and brachial neuritis. "The clinical picture in subacromial bursitis and supraspinatus tendon rupture simulates that of scalenus anticus syndrome in that the pain in both is apt to be referred to the shoulder. In the former, however, tenderness is limited over the supraspinatus tendon and subacromial bursa without other accompanying nervous and vascular manifestations."

Unquestionably, the so-called scalenus anterior syndrome exists as a not uncommon condition, and, when uncomplicated by other lesions about the shoulder joint or the cervical spine, it is cured by a tenotomy of this muscle. During the past three years many cases have been recognized and subjected to surgery, with relief of symptoms (Craig and Knepper; and Henschen and Heusser). Spurling and Bradford have reported a series of twenty-one cases, and, to the writer's knowledge, many other surgeons have had similar success following the recognition and treatment of this condition.

However, the clinical picture of scalenus anterior syndrome may be much more complicated and have far more intimate associations with other lesions than has been suggested by Ochsner and his associates. In fact, it has been the experience of the author to find the scalenus anterior syndrome a sequela of primary lesions of the shoulder joint and cervical spine much more frequently than as an isolated clinical entity. So often is this the case that orthopaedic surgeons should be doubly indebted to Ochsner and Naffziger for bringing this syndrome to their attention.

Untold numbers of cases of so-called brachial neuritis, associated

# THE SCALENUS ANTERIOR MUSCLE IN RELATION TO SHOULDER AND ARM PAIN *

BY JOSEPH A. FREIBERG, M.D., CINCINNATI, OHIO

*From the Department of Orthopaedic Surgery, University of Cincinnati*

The rôle played by the scalenus anterior muscle in certain nervous and vascular disturbances of the shoulder and arm was suggested by J. B. Murphy in 1906. The actual part played by this muscle in the complications arising in the presence of a cervical rib was not clearly understood until 1927, when Adson and Coffey pointed out that sectioning of this muscle would relieve the symptoms associated with cervical ribs. In fact, since their able and thorough explanation of this symptom complex, the more tedious and hazardous resection of the cervical rib is rarely done. There are in the literature numerous reports of isolated cases and small series of cases, manifesting symptoms of brachial-plexus and subclavian-artery compression attributed to highly situated first ribs. Brickner and Milch, in 1925, as well as others, advised partial resection of the first rib, and obtained satisfactory results.

Three years ago, Ochsner, Gage, and DeBakey reported a series of six cases presenting the clinical picture of cervical rib, but in which no cervical rib could be demonstrated. These authors termed this condition "scalenus anticus (Naffziger) syndrome". In this most excellent contribution, a clinical picture, previously unidentified, was fully and adequately portrayed. Ochsner and his associates described the syndrome as characterized by pain referred to the shoulder, to the supraclavicular area, down the arm to the ulnar and flexor surfaces of the forearm to the hand, and frequently to the side of the neck and the ear. The author has noted rather frequently that pain is also present in an area between the spine and the mesial border of the scapula. The symptoms varied from an uncomfortable tingling or numb sensation to severe lancinating pain. Pressure over the scalenus anterior muscle produced ulnar pain. Likewise, if the head was turned toward the affected side with the neck extended, on deep inspiration or depression of the shoulder the pain was increased. Associated with this syndrome, or as a part of it, were vascular manifestations, consisting of diminution of pulse volume on the affected side, decreased skin-surface temperature, numbness, coldness, and formication of the arm. These vascular changes could be proved by oscillometric tests. Todd, in 1912, ascribed an abnormal compression of the subclavian structures to an abnormal development of the shoulder girdle. He stated that when either the sternal end of the shoulder girdle presented an arrested descent or the acromioclavicular descent was in-

* Read at the Annual Meeting of the American Orthopaedic Association, Atlantic City, New Jersey, May 3, 1938.

FIG. 2-B



FIG. 2-A

Anteroposterior and lateral roentgenograms of a patient who had an old traumatic arthritis of the fifth, sixth, and seventh cervical vertebrae with an associated scalenus anterior syndrome on the right side and extensive weakness of the muscles of the upper arm and shoulder. The patient was cured by a scaleniotomy. Compare this normal relationship of rib and shoulder girdle with Fig. 1.

with such lesions as arthritis and periarthritis of the shoulder, cervical arthritis, bursitis of the subacromial bursa, and partial rupture of the supraspinatus tendon, have been encountered and described. The clinical picture of such a common condition as calcification of the supraspinatus tendon is not infrequently complicated by pain, paraesthesia, and numbness and swelling of the lower arm and hand. On what anatomical basis can an isolated lesion about the superior surface of the shoulder capsule account for pain in the forearm and hand? Likewise, on what anatomical basis can the true picture of pain and weakness of the arm and diminished skin temperature be associated with infectious and traumatic lesions of the cervical spine? Why do these complications disappear following local therapy to these lesions of the cervical spine and the shoulder?

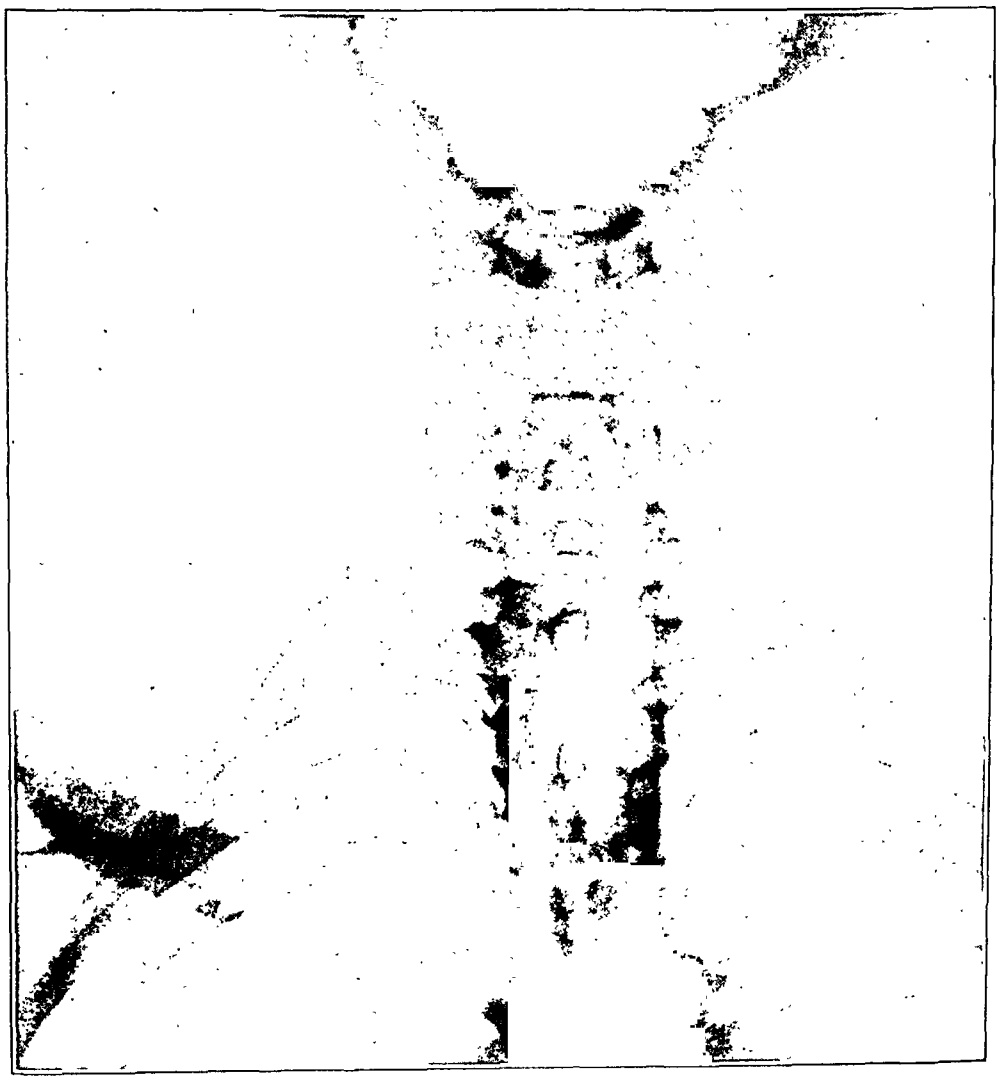


FIG. 1

Roentgenogram of patient with bilateral scalenus anterior syndrome, illustrating anatomical type with abnormal shoulder descent and long neck. The first costosternal unction is superimposed over the fifth thoracic vertebra. The patient was relieved by postural instruction.

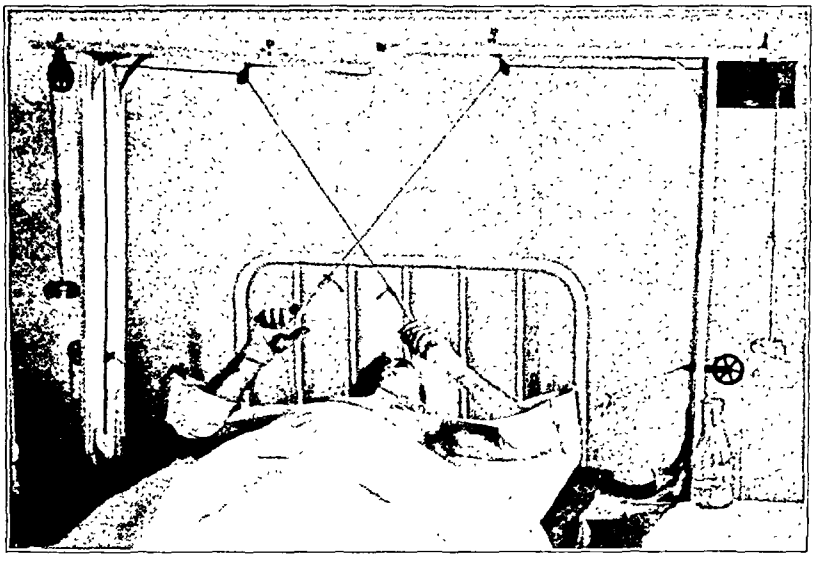


FIG. 3-B

Same patient as in Fig. 3-A shown in simple balanced forearm traction which relieved the signs and symptoms of bilateral scalenus anterior syndrome.

root, is most frequently affected, although the cutaneous nerve of the neck and the occiput and the nerve to the trapezius muscle, arising from the third cervical root, are not infrequently involved.

Spasm of the scalenus anterior muscle, or spasm of the muscle associated with hypertrophy or eventual contracture, may result in a variable degree of damage to the cervical roots lying behind the muscle. This lesion of the roots may manifest itself as a simple nerve irritation with cutaneous or muscle pain in the areas supplied by the involved roots, or, if the lesion is of long standing, actual muscle weakness and paralysis may occur. These symptoms and signs, similar to those associated with cervical or supernumerary ribs, have been found in numerous cases. The vascular symptoms consist of a sensation of coldness, usually in the hand, and recurring or persisting swelling and patchy areas of subjective numbness, often without actual disturbance of sensation. Probably the most common complaint by the patient is that of a dull ache in the hand and the forearm, associated with a feeling of continual pressure as if something were squeezing the extremity from without. The areas of subjective pain, as has been stated, may be referred to any or to all of the skin areas supplied by the third, fourth, fifth, sixth, seventh, and eighth cervical roots. Weakness of the deltoid, of the biceps, of the triceps, and of the flexor muscles of the hand is most easily identified in a cursory examination. There is, however, no exact pattern of muscle lesions found in all of these cases.

For this discussion, the scalenus anterior syndrome associated with the anatomical skeletal variation is of least concern. Having mentioned

A patient with abnormal descent of the shoulder girdle, characterized by sloping shoulders and an apparently long neck, is the anatomical type in which a scalenus anterior syndrome is more likely to develop. In roentgenograms of the base of the neck, taken in the anteroposterior plane with the tube centered over the first thoracic vertebra, ordinarily the first costosternal junction will be superimposed over the third thoracic vertebra. In this anatomical variant, as illustrated in Figure 1, the first costosternal junction is seen superimposed over the fifth thoracic vertebra. This anatomical configuration may be associated with faulty posture and a consequent backward position of the shoulders, a predisposing factor to scalenus anterior syndrome. As Todd stated, the shoulder girdle descends farther in women than in men. Therefore, it is to be expected that the scalenus anterior syndrome will be more frequently encountered in women. Although abnormal descent of the shoulder girdle is a predisposing factor, numerous cases of scalenus anterior syndrome have been encountered in individuals who do not present this anatomical variation. (See Figures 2-A and 2-B.)

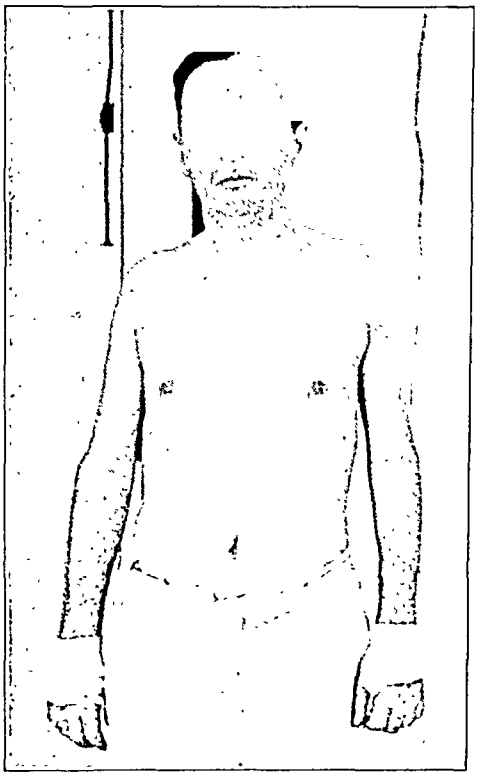


FIG. 3-A

Photograph of a patient who had an inadequately immobilized fracture of the left clavicle, which eventually united with angulation. Because of constant pain during treatment of the fracture, the shoulders were held voluntarily depressed and immobile. Marked signs of bilateral scalenus anterior syndrome developed, which persisted and incapacitated the patient for five months. The patient was relieved by bilateral arm traction (Fig. 3-B).

The scalenus anterior muscle arises from the transverse processes of the third, fourth, fifth, and sixth cervical vertebrae. The muscle extends downward and slightly forward to insert into the anterior third of the first rib at the scalene tubercle. When the cervical spine is fixed, the muscle elevates the first rib. When the first rib is fixed, the joint action of the two anterior scaleni flexes the cervical spine. The subclavian artery arches laterally between the scalenus anterior muscle and the first rib. Likewise, emerging from the cervical vertebrae and extending downward and laterally, the third, fourth, fifth, sixth, seventh, and eighth cervical nerves pass from behind the scalenus anterior muscle to form the cervical and brachial plexuses. As the sixth, seventh, and eighth cervical nerves lie in close approximation to the subclavian artery and the scalenus anterior muscles, these nerves, or the areas supplied by them, are more frequently involved in lesions of the scaleni. In other words, the ulnar nerve, arising from the eighth cervical

syndrome is not indicated, as conservative therapy has resulted in the cure of cases in the past and will continue to do so in the future if the etiological factor is removed in a reasonable period of time.

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as would be expected. In the case of the long-standing arthritis of the fifth, sixth, and seventh cervical vertebrae with the bilateral scalenus anterior syndrome of three years' duration, there was considerable muscle weakness of the shoulder girdle and forearms associated with neuritic pain. Under local anaesthesia, a scaleniotomy was performed on one side, with marked subsidence of pain and some return of muscle power. This patient has not returned. One patient with bilateral scalenus anterior syndrome and unusually sloping shoulders (Fig. 1) obtained sufficient relief from postural instruction so that operation was not indicated. Several patients, following moderate relief from conservative therapy, have refused scaleniotomy, although operation probably would have given complete relief.

In summarizing the results of conservative therapy in this series of twenty cases and a larger series of out-patient and office cases, it is the opinion of the author that in the presence of a syndrome of three months' duration with definite muscle weakness and signs of vascular interference, scaleniotomy should probably be done. However, sufficient improvement has followed conservative therapy in many instances to warrant its trial in all but the most extreme cases. In this series, the one exception was made in the case of a fireman who developed the scalenus anterior syndrome following ladder drill and had such excruciating pain that he had not slept for ten nights. He stated that, following the scaleniotomy under local anaesthesia, he noted, while he was being returned on a stretcher from the operating room, that the pain had disappeared entirely. He has remained cured since the operation.

From the study of the cases mentioned in this discussion, it is the opinion of the author that the diagnosis of brachial neuritis should not be made unless it can be substantiated by a neurologist who likewise understands the multitudinous associations of the scalenus anterior syndrome, and can attribute the neuritis to a proved etiological factor.

## CONCLUSIONS

1. The scalenus anterior syndrome, a lesion of combined vascular and neurological signs and symptoms in the shoulder, the arm, and the hand, may be dependent upon an anatomical type plus a lesser trauma or strain of the shoulder girdle.

2. Lesions of the cervical spine may induce spasm of the scalenus anterior muscle with the resultant syndrome.

3. Traumatic and infectious lesions of the shoulder girdle may induce or be associated with the scalenus anterior syndrome.

4. When cervical or shoulder-girdle lesions are amenable to therapy, the scalenus anterior syndrome may subside without specific therapy.

5. In the anatomical type, or in the long-standing scalenus anterior syndrome from other causes, with hypertrophy or contracture of the scalenus anterior muscle, scaleniotomy is indicated.

6. Indiscriminate scaleniotomy in all cases of the scalenus anterior

no one etiological factor, no single infection, dietary abnormality, or metabolic derangement has been conclusively shown to be the prime cause of the disease."

In the light of this pronouncement we return to the theoretical considerations upon which the operation of synovectomy was originally applied to chronic atrophic arthritis:

1. The first consideration was the possibility of promoting the resumption of joint function by the operative removal of the organized inflammatory exudate and the possibility of preventing such further joint damage as would result from the continued presence of unabsorbed exudate. The validity of this theory has been established by practical application at the hands of many surgeons, both in the United States and abroad. The theory has also been sustained by the brilliant pathological studies of Nichols and Richardson. Nearly thirty years ago these advanced students published their findings and conclusions. They showed that primary proliferation of the synovial membrane constitutes the first change in the atrophic type of arthritis. This proliferation of the synovia causes a layer of granulation tissue to extend in the form of a pannus more or less completely over the joint cartilage. This granulation tissue, if it comes directly in contact with the cartilage, causes destruction and absorption of the cartilage. The perichondrium may begin to proliferate simultaneously with the synovia and, if and when it does, there is induced the formation of a layer of special connective tissue, of cartilage, or even of bone. From this it appears to be clear that there is a type of atrophic arthritis in which the proliferative process is confined to the synovia, and it is in this type that it is reasonable to expect the greatest benefit from synovectomy. Such benefit may have the dual nature of improving the immediate mechanics of the joint and of preventing the destruction and absorption of the cartilage by pannus pressure.

2. The second original consideration concerned the possibility of assisting the local and general recovery by eliminating the metastatic foci of infection in the joints themselves. Subsequent work on arthritis does not provide a sufficient basis for supposing that the synovial membrane is the site of actual bacterial invasion in chronic atrophic arthritis. While the actual dynamics of the relationship between distant foci and the joints remains hazy, this theoretical consideration ought not to be stressed.

3. The third theoretical consideration for recommending synovectomy was based on the stimulation of the metabolism and the decrease in the suboxidation processes with lowered sugar tolerance which Pemberton had found to accompany arthritis, improvement in which might be expected to follow the restoration of joint function. To the extent that these subversive chemical states are influential in the continuation of the disease, the benefits of synovectomy may reasonably be expected to follow.

Therefore, of the three theoretical considerations which originally led up to this operation, the first and third still seem to be valid, while the second must be abandoned in the present state of our knowledge.

# GIANT-CELL TUMOR OF BONE *

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NEW YORK, N. Y.

The giant-cell tumor was recognized more than a hundred years ago by Sir Astley Cooper, who, in 1818, described the following physical signs: swelling, expansion of bone, ulceration, sloughing, and bloody discharge. The benign nature of the tumor is said to have been pointed out first by Lebert in 1845. Later, Paget, in 1853, gave what Bloodgood declared to be the most accurate description of the tumor ever published. In a lengthy monograph, Nélaton, in 1860, described in full the gross, microscopic, and clinical features of the disease, and emphasized the fact that it is only locally malignant. Two years later, Virchow suggested that the giant-cell tumor might recur and might even prove malignant. He alluded to the "degeneration into cancer" spoken of by authors since Paré and Fernel. In opposition to this, Gross, in 1879, gave a detailed analysis of seventy cases and insisted on the benign character of the lesion. He pointed out the difficulty of distinguishing it from the malignant medullary sarcoma of aneurysmal type.

In more recent years, Bloodgood, Codman, and William B. Coley have contributed conspicuously to our knowledge of this tumor, as have Nové-Josserand and Tavernier, Platt, and Barrie.

We find Pfahler and Herendeen in the vanguard of the steadily increasing number of radiologists who are staunch advocates of radiation for this type of tumor.

Among the pathologists of our day to whose intensive and painstaking study we owe much of our knowledge of the nature of the giant-cell tumor, are Ewing, Mallory, Goforth, and Stewart.

Finally, and of outstanding importance, is the part played by the Registry of Bone Sarcoma of the American College of Surgeons. This Registry, founded some two decades ago by Codman, has served as a clearing-house of information bearing on the results obtained by various methods of treatment, and on ultimate prognosis.

## ETIOLOGY

Despite the variety of opinions offered by careful observers, the causative factor responsible for the giant-cell tumor has not as yet been definitely determined. Several theories have been advanced. Among them may be mentioned: (1) the *neoplastic* theory, which assumes a true tumor originating in bone marrow; (2) the *non-neoplastic* theory, which holds the condition to be not a tumor but a result of chronic inflammation or chronic irritation,—*i.e.*, faulty-repair phenomenon (Mallory) or chronic hemorrhagic osteomyelitis (Barrie); (3) the *traumatic*

* Read by invitation at the Annual Meeting of the American Orthopaedic Association, Atlantic City, New Jersey, May 3, 1938.

theory, which assumes that an injury induces a subcortical hemorrhage in cancellous bone, and the area involved extends gradually and progressively destroys more and more bone. Codman has elaborated on this theory. He feels that it explains the nature and growth of the giant-cell tumor. In his opinion: "The essential structure of a giant cell tumor is simple, for it contains no walled blood vessels and the corpuscles circulate through its interstices as if it were a sponge. Therefore, the whole sponge pulsates and tends to expand its bony walls by destroying its rigid boundaries. It does not advance down the soft marrow because the latter also pulsates with the same heart beats, nor does it invade joint cartilage which is elastic and accustomed to the intermittent pressure of weight bearing . . . I conceive the lumen of the artery which supplies it to be in direct communication with the interstices of the sponge and the emissary veins to be likewise the recipients of the corpuscles which have threaded their devious ways through the sponge. . . . The giant cells are not free. . . . They are nodes in strands of tissue remarkably evenly spaced throughout the cavity and line its walls. Complications in this simple picture include hemosiderin in nearly every case, indicating a traumatic origin."

In connection with the last-named theory, we would point out that the series of giant-cell tumors of long bones reported by William B. Coley showed a history of antecedent trauma in 50 per cent., and the Johns Hopkins series (Geschickter and Copeland), in 42 per cent. We believe that the *traumatic* theory offers the most logical explanation.

## LOCATION

The giant-cell tumor is primarily an affection of the long bones of the extremities, occurring but infrequently in flat bones. It originates

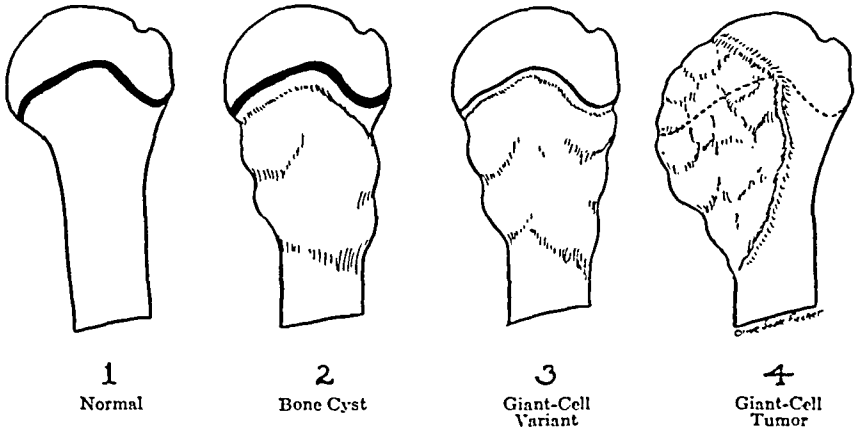



FIG. 1

Schematic drawing showing location, in respect to the epiphyseal line, of the involved area in bone cyst (*2*), giant-cell variant of bone cyst (*3*), and giant-cell tumor (*4*).

Note especially the proximity of the process to the epiphyseal line in *3;* also that the epiphysis is about to unite. Note also that in *4* the process involves the head rather than the shaft side of the epiphyseal line (now united), although it extends across to involve the metaphyseal area somewhat.

TABLE I

LOCATIONS OF GIANT-CELL TUMORS

| Site | Series from Memorial Hospital and Hospital for the Ruptured and Crippled (124 Cases) | | | Schinz and Uehlinger's Series Collected from Literature (385 Cases) | | |
|---|---|---|---|---|---|---|
| | *Cases* | *Proximal* | *Distal* | *Cases* | *Proximal* | *Distal* |
| Femur | 37 | 6 | 31 | 139 | 16 | 123 |
| Tibia | 37 | 35 | 2 | 106 | 92 | 14 |
| Radius | 8 | 1 | 7 | 65 | 3 | 62 |
| Humerus | 6 | 5 | 1 | 27 | 27 | 0 |
| Ulna | 2 | 0 | 2 | 29 | 7 | 22 |
| Fibula | 6 | 5 | 1 | 19 | 15 | 4 |
| Ilium | 7 | | | | | |
| Sacrum | 6 | | | | | |
| Ischium | 3 | | | | | |
| Calcaneum | 3 | | | | | |
| Vertebra | 3 | | | | | |
| Metatarsal Bones | 2 | | | | | |
| Metacarpal Bones | 1 | | | | | |
| Phalanx | 1 | | | | | |
| Rib | 1 | | | | | |
| Pubis | 1 | | | | | |

in the epiphyseal region, and extends progressively with little tendency to destroy the adjacent shaft until late in its course. By far, the most frequent sites are the femur, the tibia, and the radius. In a series of 385 collected cases, these three bones were involved in 310 cases. For a detailed description see Table I.

No examples of tumor of the patella were found in our series, but fourteen are mentioned in the literature.

The giant-cell tumor is a solitary lesion. Rare published reports of multiple involvement are, probably, examples of generalized osteitis fibrosa cystica with giant-cell tissue. However, we have once seen both femora affected at different periods, and have twice seen the process extend to a contiguous bone,—*i.e.*, from the lower tibia to the lower fibula across the inferior tibiofibular articulation, and from the upper femur across the hip joint to the acetabulum. Although of less frequent occurrence than the central chondroma in this location, the giant-cell tumor may originate in the small bones of the hands and feet.

## PATHOLOGY

The complexities of the histogenesis of the giant-cell tumor are well known. Pathological opinion differs widely. A comprehensive discussion of the subject is out of place in this paper, and those interested are referred to original sources.

Despite the advancement of many arguments that the giant-cell tumor is not a true tumor, its behavior and course reveal certain features that lead most present-day writers to regard it as such. It is difficult to conceive how a lesion that possesses the power of persistent growth and the tendency to recur after incomplete removal and to invade the adjacent tissues, and even in some instances to develop metastases, can be regarded as a chronic inflammatory process. We believe that, although it is usually benign, it is always locally aggressive and even, in a sense, potentially malignant. This latter quality seems to be inherent in cases inadequately or improperly treated.

## SYMPTOMS

Pain is usually the first symptom noted by the patient. It is not severe, it is often intermittent, and it seldom progresses as rapidly as in medullary osteogenic sarcoma. It is often described as a "dull ache" and is aggravated by activity of the part. Because of its central location, the giant-cell tumor does not give rise to a visible swelling or palpable tumor in the early stages. Later, when expansion of the cortex has taken place, a tumor may be noted by the patient or the examining physician. Disability is a variable factor; it occurs most frequently later in the disease after pain has been complained of, but often before the swelling appears. It is usually manifest in slight restriction of full range of motion of the nearby joint, and lameness after attempts at functional activity.

## PHYSICAL SIGNS

Early lesions may present little in the way of objective findings for, as already stated, the changes in the bone (swelling and cortical expansion) are not early manifestations. Later there will be evidence of increase in size, interference with full range of motion, and, occasionally, increased surface temperature, and even, in rare instances, pulsation of the thin shell covering the tumor.

## ROENTGENOGRAPHIC FEATURES

This tumor usually presents a characteristic roentgenographic appearance. It shows a destructive area in the epiphyseal region which involves adjacent metaphyseal bone, but which exhibits little extension to cortical bone of the shaft. The area of involvement is irregularly spherical, shows trabeculations due to destruction of the cancellous bone,

TABLE II

AGE INCIDENCE OF GIANT-CELL TUMORS

| Period | Series from Memorial Hospital and Hospital for the Ruptured and Crippled (124 Cases *) | Combined Series of Christensen (341), W. B. Coley (50) and Behring (26)—Total of 417 Cases |
|---|---|---|
| *Years* | *Cases* | *Cases* |
| 0 to 10..... | 1 | 23 |
| 11 to 20..... | 21 | 106 |
| 21 to 30..... | 48 | 150 |
| 31 to 40..... | 30 | 63 |
| 41 to 50..... | 16 | 49 |
| 51 to 60..... | 6 | 19 |
| 61 to 70..... | 2 | 7 |

* Oldest patient, 62 years; youngest, 5 years; average age of patients, 29.7 years.

and tends to extend across the bone to destroy the whole transverse diameter before progressing shaftward. While it may extend to the cartilage of the articulation, it seldom invades it, and even late in the disease this structure remains intact. When erosion has progressed sufficiently to expand the cortex, it may later destroy it so completely that no evidence of a bony shell is seen in the roentgenograms, and only the periosteum remains as a limiting membrane. When pathological fracture occurs, it is apparent on roentgenographic examination, although marked displacement is unusual. However, the affected side of the bone is usually compressed, so that tilting is seen and irregularity of the joint surface is produced.

## AGE INCIDENCE

As will be seen by Table II, this disease is one of youth and early middle life, occurring most frequently in the decade from twenty-one to thirty years.

TABLE III

SEX INCIDENCE

| Sex | Series from Memorial Hospital and Hospital for the Ruptured and Crippled (124 Cases) | | Series of Christensen (362 cases) | |
|---|---|---|---|---|
| | *Cases* | *Per Cent.* | *Cases* | *Per Cent.* |
| Female..... | 56 | 45 | 192 | 53 |
| Male..... | 68 | 55 | 170 | 47 |

TABLE IV

DIFFERENTIAL FACTORS

| Factors | Bone Cyst | von Recklinghausen's Disease | Giant-Cell Tumor |
|---|---|---|---|
| Age | 5 to 18 years | Young and middle-aged adults | Young adults (20 to 40 years) |
| Location | Metaphysis | Generalized, usually in shaft | Epiphysis |
| Bone Involved | Upper femur, humerus, and tibia | Many bones | Lower femur, upper tibia, lower radius, and upper humerus |
| Fracture | Frequent (50 per cent.) | Frequent | Less early, but in 25 per cent. |
| Gross Appearance | Multilocular, serous | Multilocular | Friable, reddish-brown, bloody |
| Appearance of tissue | Whitish | Fibrous | Reddish |
| Giant Cells | Present | May be present | Plentiful |
| Vascularity | Slight | Avascular | Very vascular, even telangiectatic |
| X-Ray Appearance | Typical | Typical | Typical |
| Chemistry | Normal phosphorus, phosphatase, and calcium | Calcium and phosphatase elevated; phosphorus diminished | Normal phosphorus, phosphatase, and calcium |

## SEX INCIDENCE

While in the second of the two series shown in Table III there is a slight preponderance of females over males, we do not believe that the relationship of sex plays an important part.

## DIFFERENTIAL DIAGNOSIS

In a recent article Codman states that there are three possibilities of error in making a diagnosis of giant-cell tumor from roentgenograms, and two from microscopic sections:

1. The films may be characteristic and yet the sections may be unequivocally in favor of some other diagnosis.

2. Both films and slides may be interpreted as giant-cell tumor and yet the rapid fatal course may indicate an error of interpretation.

3. The films, sections, and clinical course for several years may seem to assure the diagnosis and yet a sarcoma may eventually appear at the site of the lesion.

There are many bone lesions to be distinguished from the giant-cell tumor,—some are malignant, some are benign, and some are not neoplasms at all. Table IV presents the distinguishing factors and shows that age

and consequent relationship to the epiphyseal line are the most important elements to be considered in trying to differentiate them.

*Simple Bone Cyst*

This condition is most often confused with giant-cell tumor. They have many factors in common. The etiology and pathology are quite similar. Sabrazès, Jeanneney, and Mathey-Cornat, in their introductory remarks on giant-cell tumor, bone cyst, and fibrous osteitis, point out that the nature of these three conditions is not well understood, and that transitional forms may be found. They prefer to retain them under the classification of *tumors*, rather than, as Lecène and others have designated them, as *lésions dystrophiques des os*, although recognizing that their prognosis is infinitely better than that of true malignant tumors.

*Von Recklinghausen's Disease*

This disease (multiple form of osteitis fibrosa cystica) seldom offers diagnostic difficulty because the lesions are multiple and involve the shaft; in fact, except for the microscopic picture, it bears no similarity to the giant-cell tumor. The blood chemistry is important, for in both bone cyst and giant-cell tumor the serum calcium, phosphorus, and phosphatase are normal; whereas in von Recklinghausen's disease the calcium and phosphatase are increased and the phosphorus is diminished.

*Central Chondroma or Chondromyxoma*

This condition, when occurring in the epiphysis of a long bone, occasionally simulates a giant-cell tumor; the roentgenograms may even be indistinguishable. Since conservative treatment is in order for each, the diagnosis will ultimately rest on the microscopic evidence obtained either by aspiration or at operation.

*Plasma-Cell Myeloma*

This disease affects individuals who have passed the age period when giant-cell tumor is ordinarily found, yet there is a slight overlapping about the age of forty when the two may occur. In this small group, the solitary form of myeloma, especially when occurring in a flat bone such as the ilium, may resemble a giant-cell tumor very closely, and may require histological study for differentiation.

*Osteogenic Sarcoma*

The consideration of this type of bone tumor will be restricted to the form called the *medullary osteolytic* variety. This tumor often selects the same site in the bone, occurs in the same age group, has in its earlier stages a similarity of symptoms and signs, and even resembles the giant-cell tumor roentgenographically. We have encountered a number of cases that had been regarded as giant-cell tumors and treated by radiation over a long period, only to require amputation when it had become

obvious that the lesions were malignant osteolytic sarcoma and not benign giant-cell tumor. This may happen whenever a supposed giant-cell tumor is treated by radiation without microscopic confirmation of the diagnosis.

### MALIGNANT GIANT-CELL TUMOR

The question of the possible transformation of a benign giant-cell tumor into a sarcoma has been raised and discussed for more than a hundred years. It has aroused the interest of nearly every worker in the field. We have studied our cases with this question in mind, and, in an as yet unpublished paper written in collaboration with Dr. Fred W. Stewart, an effort has been made to interpret the malignant evolution of the giant-cell tumor.

From this study, we have reached the conclusion that the form assumed by the process known as the giant-cell tumor depends on the nature of the circumstances, physical and chemical, which have initiated the process, together with the extrinsic factors which interfere with its normal evolution.

From a practical standpoint, one should bear in mind that infrequently, but by no means rarely, a giant-cell tumor may exhibit all the characteristics of a benign lesion, even to the histological appearance, and yet run a course that shows it to be a malignant sarcoma. We are convinced, however, that, when this malignant change takes place, the sarcoma is not osteogenic sarcoma in the usually accepted sense, but a wholly distinct type. It shows no tendency to form bone, cartilage, or osteoid tissue. One of the confusing factors which we found was the similarity between cases apparently malignant at the outset before any treatment had been given and those in which malignant features developed at a later date following curettage or radiation or a combination of both. Some of our cases, however, in which this combined treatment was employed seemed to show so clearly a malignant transformation from an apparently benign state that we have continued to deprecate the practice.

### TREATMENT

Up to this time, two conservative methods have been devised for the treatment of giant-cell tumor,—surgical extirpation by curettage or resection, and radiation by radium pack or roentgen-ray. More radical surgery, such as amputation, is reserved for frankly malignant cases or for the exceptional case in which the tumor is situated in the lower extremity where an artificial limb assures a better functional result.

The question is not yet finally settled as to whether radiation or surgery is the better method. Some extremists would never resort to surgery, but would treat all by the roentgen-ray; others, equally extreme, would use surgery in preference to the roentgen-ray, regardless of the size, the location, or the extent of the lesion. The fact that opinion is so widely divergent would seem to indicate that neither extreme view is the

correct one, and that, until a more satisfactory answer has been found, the profession should retain an open mind on the subject. Several years ago we sent a questionnaire to a number of orthopaedic surgeons and radiologists in this country in an effort to obtain representative opinions regarding their choice of method of treatment. From their replies we learned that, for the most part, their conclusions coincided with our own,—namely, that it was best to reserve radiation for cases where the lesion was inaccessible, and to employ surgery for all others. As might be expected, we found that the surgeons more consistently favored surgery, and the radiologists, radiation.

Representative of British opinion, Platt, of Manchester, holds that "certain early giant-cell tumors should be curetted and others excised"; and Elmslie, of London, that "benign giant-cell tumors should always be treated surgically".

As has already been stated, our experience has led us to adopt surgery for lesions that are accessible, especially those situated in the region of the knee, and radiation for lesions that are inaccessible, especially those in the spine, in the pelvis, or in the neck of the femur. We avoid the use of radiation and surgery in the same case. Borderline cystic lesions and true bone cysts are treated according to the same criteria and following the same principles. It should be remembered, however, that, since cysts are usually seen in individuals who have not attained full bone growth, the effect of the roentgen-ray on the adjacent epiphysis may result in retardation of growth and consequent bone shortening. This is of more moment in the lower extremity. Cases of advanced giant-cell tumor, in which the bony shell has been completely destroyed, are sometimes unsuitable for operation. Some of these have responded well to radiation.

## TECHNIQUE OF CURETTAGE

Since a full description of the technique employed appears in a previous paper published by the authors in 1936, only a brief reference to the more important points will be given here.

As our aim in all cases is perfect wound healing, particular emphasis is laid on a thorough skin preparation (we use a forty-eight-hour preparation). Protection of the wound edges with towels fastened with Michel clips is recommended. Uncontrolled bleeding may be forestalled by the use of an Esmarch bandage or tourniquet. Accurate hemostasis of soft tissues is essential. A large window cut in the cortex assures good exposure. The periosteum is preserved. The thoroughness with which the cavity is curetted is a measure of the probable successful result. The cavity is swabbed with zinc chloride and flushed with Dakin's solution or normal saline. The wound is closed layer by layer. Packing or drainage of the wound is strongly condemned. Firm, snug dressings of gauze-roll and sheet-wadding, held by flannel bandage reinforced with adhesive strips, maintain pressure evenly and help prevent wound

infection by avoiding hematoma. Elevation of the part for from forty-eight to seventy-two hours minimizes swelling and prevents excessive oozing. The wound is not disturbed for a week. If the degree of involvement suggests the danger of a pathological fracture, protection by splints or by plaster casings is provided. Weight-bearing is avoided until regeneration of bone is believed to be adequate. Motion of the contiguous joint is encouraged at the earliest moment possible. Caliper splints for tumors of the tibia and femur permit walking, without danger of late fracture. This activity hastens bone regeneration. Appropriate splints are used for lesions in the upper extremity.

We have not found it necessary to use bone chips, and we believe it is unwise to fill the curetted cavity with them as has been recommended by some surgeons. Muscle and fat grafts are mentioned only to be condemned.

### RESECTION

Subperiosteal resection in preference to curettage has been recommended by several authorities. Tumors of the upper fibula, of the metatarsus, and of the rib may be satisfactorily handled in this manner. However, curettage has been followed by recurrence so infrequently in our experience that the occasion for resection has seldom arisen. It may be useful in the recurrent case in preference to a second curettage.

### AMPUTATION

Only on extremely rare occasions should it be regarded as necessary to amputate a limb. In the past, amputation had to be resorted to in some cases in which the wound was packed following curettage, or in which infection and fungation followed the use of radium implanted in the cavity. Since the technique of operation has been altered and the wounds invariably closed without drainage, we have never amputated except where a malignant transformation of the tumor has taken place. Several cases have come to amputation following radiation because of complications or sequelae such as radiation osteitis with fracture and non-union, ulceration, infection, etc.

### RADIATION THERAPY

While both the radium pack and the roentgen-ray are used in the treatment of giant-cell tumors, the latter has many advantages over the former. It is widely available in every large city, it is more economical, and a shorter time is required to deliver a comparable dose.

In the past, the doses of roentgen-ray employed were often much too large or were repeated too frequently, so that many of the unfortunate end results are chargeable to overtreatment.

One difficulty has been that a dose adequate for one patient was insufficient for another. No generally accepted standard of technique has been devised.

TABLE V

RESULTS OF TREATMENT OF 124 CASES† OF GIANT-CELL TUMOR

| Treatment | Cases | Excellent Result | | Good Result | | Poor Result | | Unclassified |
|---|---|---|---|---|---|---|---|---|
| | *No.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* |
| Surgery alone... | 35 | 17 | 57 | 6 | 20 | 7 | 23 | 5 |
| Radiation alone | 53 | 14 | 34 | 12 | 30 | 15 | 36 | 12 |
| Surgery and radiation combined..... | 34* | 7 | 22 | 8 | 25 | 17 | 53 | 2 |
| Coley's toxins alone..... | 2 | 1 | 50 | 1 | 50 | | | |

* Of these thirty-four patients treated by surgery and radiation combined, thirty had postoperative radiation; in only four cases was preoperative radiation used. Of the latter, there was a recurrence in one and a second operation was required; in another the tumor became malignant shortly after curettage, amputation was performed and the patient died of metastases; three patients are living and well.

† It should be noted that the unclassified results were deducted from the total number of cases before the percentages were computed.

We believe that the present tendency to use smaller doses, to repeat the cycles less often or at longer intervals, and to withhold later treatment in the absence of symptoms and in the presence of a favorable roentgenographic appearance, is all sound practice. With it, we believe that better results will be obtained.

Furthermore, it is our view that, where experience in the surgical treatment of this condition is lacking, roentgen therapy is the safer procedure.

*Technique of Radiation of Giant-Cell Tumor*

It is the feeling at the Memorial Hospital that a voltage of 200 kilovolts is employed too frequently, and that, from the standpoint of selec-

TABLE VI

ANALYSIS OF TWENTY-SIX * CASES OF GIANT-CELL TUMOR IN WHICH AMPUTATION WAS PERFORMED

| Secondary Amputation (24 Cases) | Type of Previous Treatment | | |
|---|---|---|---|
| | Surgery | Radiation | Combined |
| For infection..... | 2 | 0 | 2 |
| For radiation changes..... | 0 | 4 | 2 |
| For malignant transformation..... | 1 | 0 | 6 |
| For failure to control disease..... | 2 | 3 | 2 |
| Total..... | 5 | 7 | 12 |
| Percentage of followed cases..... | 17 | 17 | 37 |

* Primary amputation was done in two cases; secondary amputation in twenty-four.

TABLE VII

SUMMARY OF RESULTS OF TREATMENT IN 124 CASES OF GIANT-CELL TUMOR AT MEMORIAL HOSPITAL AND HOSPITAL FOR THE RUPTURED AND CRIPPLED

| Results | | Patients |
|---|---|---|
| Alive and under observation | | 83 |
| Lost to follow-up | | 19 |
| Dead: | | |
| Causes related to bone tumor | 14 | |
| Causes unrelated to bone tumor | 4 | |
| Causes unknown | 4 | |
| | — | 22 |
| Total | | 124 |

tion of physical factors, for a tumor occupying a relatively superficial position—around the knee where the majority occur—a lower voltage, say, from 125 to 150 kilovolts with a four-millimeter aluminum filter, at a target-skin distance of from twenty-five to thirty centimeters is preferable. Moderately heavy doses are given with the above factors, a suberythema or threshold dose (approximately 500 roentgen units, depending on the size of the part) being administered at a single treatment. The ports are treated at intervals of from four to seven days. A cycle might consist of four exposures,—two to each port.

It must be clearly understood that these doses are rough approximations only, and that, due to the marked variations in radiosensitivity, there is no standard method or dosage in the roentgen-ray treatment of giant-cell tumors.

The same principles of adequate support during the period when bone regeneration and repair are taking place hold for cases treated by radiation as obtain for those treated by curettage. As a rule, however, regeneration and healing require a much longer period under radiation than under surgery, so that in the former group the casts and braces must be worn over a much longer period.

## RESULTS

For a full explanation of the results obtained by the various methods of treatment see Tables V, VI, and VII.

It will be noted that surgery alone yielded the largest proportion of excellent results and the smallest proportion of poor results, that radiation alone gave the next best, and that combined surgery and radiation gave the poorest results. Coley's toxins were employed without any other treatment in two cases; in one, the result was excellent; and in the other, good.

An analysis of the twenty-six cases in which amputation was performed (Table VI) shows that in two cases amputation was performed as a primary measure; in twenty-four, as a secondary measure because of some complication such as infection, radiation osteitis or soft-tissue damage, failure to control the disease, or malignant transformation.

In addition, it is manifest that other and more subtle, though no less effective, benefits may be counted upon to take place as the consequence of better joint mechanics. There can be no doubt that the emotional state has a profound influence upon somatic conditions. Thus the feeling of courage, of confidence, and of increasing well-being that comes with lessened pain and disability reduces the emotional discontent that accompanies pain and crippling lameness. The importance of these factors can hardly be overestimated and it is likely that they constitute fundamental reasons for synovectomy.

The indications for synovectomy cannot be given categorically and they should not be dogmatically stated. It is possible to set forth only the broad outlines and, for the present at least, the decision in a given case should be made by surgeons of broad experience who alone are capable of wise opinion based on a well-rounded view of all the basic considerations. The original purpose of the operation was directed toward the treatment of chronic atrophic arthritis on the grounds already outlined, and the validity of these considerations appears to be substantiated by the author's subsequent experience, as well as by the reports of others. Thus, in 1929, Allison and Coonse, in an analysis of fifty cases of chronic infectious arthritis operated upon between 1923 and 1928, reported that 90 per cent. of these patients were relieved of pain and 65 per cent. showed marked general improvement. They expressed the opinion that a synovial membrane which shows signs of subacute synovitis —local tenderness, pain on motion, and stiffness of the joint—and excess of synovial fluid is the type for which synovectomy is indicated. It is gratifying that these writers added that, while synovectomy is most frequently performed on the knee, it may be used with effect on other joints especially in multiple arthritis.

It is interesting to compare these remarks with what was said by the author in 1922: "Apparently the operation is most likely to succeed if it is done in the type of case or at the stage of the disease where the damage is entirely synovial, the effusion extensive, and the cartilages are not ulcerated." In connection with the type of case or the stage of the disease, it is important to refer to the pathology as pictured by Nichols and Richardson. It will be remembered that they described two types of proliferative arthritis,—in one the proliferative process was confined to the synovia and in the other there was a simultaneous proliferation in the perichondrium. It is logical to believe that the operation will be most helpful when it is applied to the cases in which the proliferative process is confined to the synovia. The difficulty lies in our inability always to distinguish these two types during the early stages of the disease, but it may be hoped that an increasing awareness of the necessity for this differentiation will lead to a greater skill in roentgenographic interpretation, which will aid us in making this distinction.

With regard to further indications for or against synovectomy in chronic atrophic arthritis, it hardly seems necessary to add that the

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A noteworthy fact, and one that we have previously pointed out, is that, while 17 per cent. of the cases treated by surgery alone and 17 per cent. treated by radiation alone later came to amputation, in a third group, treated by radiation and surgery combined, this drastic operation was required in a much larger percentage of cases,—namely, 37 per cent.

## CONCLUSIONS

1. The giant-cell tumor is usually benign, but malignant forms are encountered and may result from the transformation of a tumor that is histologically benign at the outset.

2. Surgical extirpation (curettage, resection, and, on rare occasions, amputation) and radiation have been established as successful methods of treatment. Surgery is preferable for accessible tumors, and radiation for inaccessible or extremely advanced tumors.

3. Caution should be exercised when using the roentgen-ray without histological confirmation of the diagnosis, for one may be dealing with an osteolytic sarcoma which bears a close resemblance, roentgenographically, to the giant-cell tumor.

4. Radiation should not be used in conjunction with surgery. Each method should bear the full responsibility of its employment in the individual case.

5. The roentgen-ray in large doses destroys the regenerative powers of the bone; in small doses, it may fail to arrest the disease; therefore, the exact dosage for the individual case is a matter of profound judgment or of fortuitous circumstance.

6. Inexpert radiation is probably less hazardous than surgery in the hands of one unfamiliar with technical operative details. Loss of limb may ultimately result in either instance.

7. Surgical attack should envisage thorough removal of all tumor tissue through adequate exposure, careful wound closure without packing or drainage, and primary wound healing.

8. Protection during the regenerative phase is essential, regardless of the treatment employed, for a pathological fracture usually spells functional impairment and a painful neighboring joint.

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# THE MECHANICS OF THE FORMATION OF THE "SECONDARY ACETABULUM" IN CONGENITAL DISLOCATION OF THE HIP

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Lorenz, in his monograph published in 1920, claimed that dislocation of the head of the femur from the acetabulum occurs only after birth and that all cases in which dislocation occurs before birth are of a teratoid nature and, combined with other deformities, occur very infrequently. He, therefore, regarded these luxations of the hip as "so-called congenital". Since the appearance of this monograph, Harrenstein and others have described many cases in which dislocation was determined as having occurred before birth and still further cases in which dislocation of the hip was demonstrated within the first few hours or days of life. These facts led Hilgenreiner to deny the assumption of Lorenz.

Every observer of considerable experience in closed reduction of congenital dislocation of the hip recognizes certain cases in which reposition of the head either cannot be accomplished or can be attained only with great difficulty. For years the author has been studying to determine the reason for this and has been led to the supposition that perhaps those cases in which reduction is impossible or extremely difficult, in spite of the fact that the patients are of the age when this manoeuver is generally easily accomplished, are of "true congenital" nature. To verify this, the author has examined the mechanics of the formation of the secondary acetabulum.

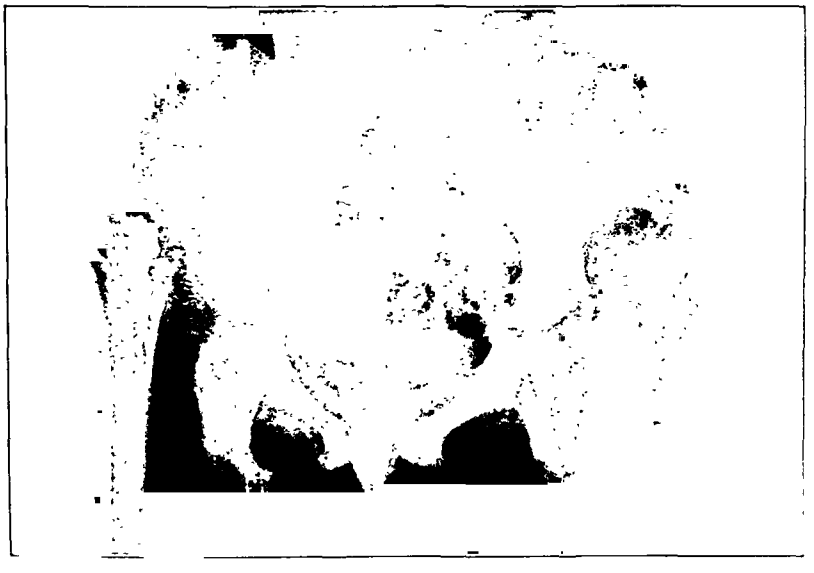


FIG. 1

Patient, two years of age. Congenital dislocation of the hip combined with other severe deformities (club-foot, loss of one ear, cryptorchidism).

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muscle control, glides freely in each direction on the wall of the pelvis during each movement of the leg. As a result, the secondary acetabulum is large and shallow and, with the occasional exception of the lower edge, is without well-formed borders. (See Figure 3.)

These facts seem to be of great pathognomonic and diagnostic importance. In the so-called congenital cases, the secondary acetabulum has a well-shaped lower border; in the true congenital cases, a well-shaped upper border. In the former, the head forms its socket by gliding and rubbing; in the latter, by direct pressure.

The reason for the difference in location of the definitely formed border is evident. In the so-called congenital cases, the gliding head has but one fixed point from which it starts during the movements of walking, etc., and to which it always returns and remains during rest. Therefore, this area on the ilium becomes well shaped and firm and corresponds to the lowest point to which the head returns in function and in rest. During the night, the head clings to the ilium and deepens the socket still further, as it does in the true congenital cases. In the latter, the boring head cannot, in functioning, extend beyond its upper border which is firmly formed in the embryonic stage. During all movements, particularly in walking, the head always returns to this area and, by its pressure, constantly increases the depth of the groove. If one takes into consideration the depth of the groove of the secondary acetabulum in cases of true congenital dislocation, together with the fact that its borders are sometimes almost as firm and well defined as are those of the physiological acetabulum, one can easily understand why reduction in these cases is difficult or even impossible, for, in later stages of dislocation, reposition of the head into the physiological acetabulum has to be preceded by dislocation from the secondary acetabulum.

These cases were recognized in the early part of the author's studies by observing all other deformities in the same individual. (See Figures 1 and 2.) Examination of the material showed that in cases with the deep groove and well-developed upper and lower borders of the secondary acetabulum, especially when combined with other anomalies, reposition of the head was difficult or impossible.

The true congenital cases are in a very great minority. The author believes that the evidence obtained from his study not only demonstrates the manner of formation of the secondary acetabulum and supports the theory of Lorenz, but may also aid in establishing the prognosis in regard to the final result of treatment of congenital dislocation of the hip.

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FIG. 2

Patient, five months old. Congenital dislocation of the hip combined with other deformities (luxation of one knee and slight club-foot).

The formation of the secondary acetabulum in true congenital dislocation must differ mechanically from that in so-called congenital dislocation. If the luxation occurs during the embryonic stage, the secondary acetabulum is the effect of the continuous pressure of the head against the wall of the ilium. The site of attachment remains the same until birth, with the result that the groove which is produced by the pressure of the ever enlarging head becomes constantly deeper, and finally resembles a physiological acetabulum (Fig. 1). The borders of this newly formed acetabulum surround the head on each side, but the upper border is particularly well developed (Fig. 2).

In dislocations occurring after birth, the secondary acetabulum is formed in quite a different manner, and is the result of friction of the gliding head on the ilium. The shape of the newly formed acetabulum has no resemblance to the normal one. The head of the femur, due to lack of



FIG. 3

Patient, two and one-half years of age. Congenital dislocation of the hip.

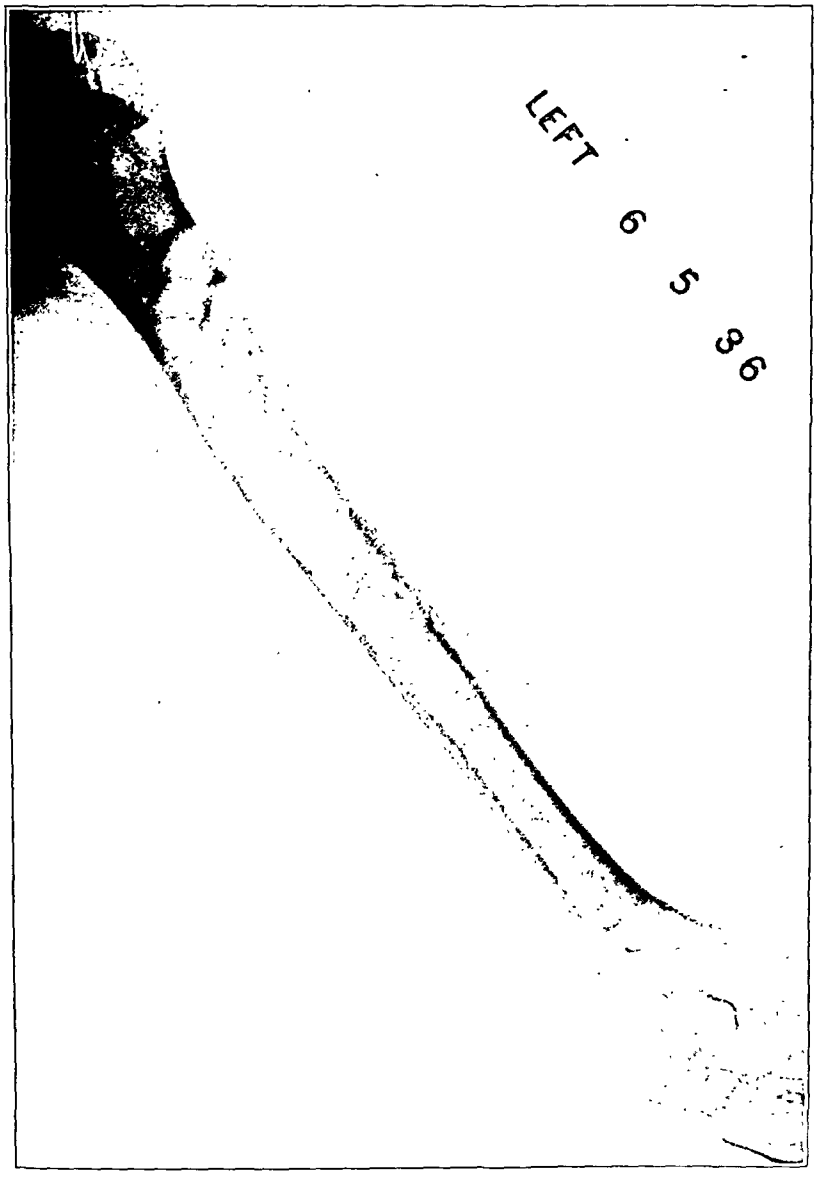



FIG. 2
Case 1. Two years later.

None of the reports since the review of Bucy and Capp gave proved cases involving bones of the extremities.

The total number of reported cases of symptomatic primary hemangioma involving bones of the extremities is, therefore, eleven. Four additional cases are reported herein.

## CLINICAL FEATURES

The youngest patient was eight; the oldest, twenty. There was an

# PRIMARY HEMANGIOMA INVOLVING BONES OF THE EXTREMITIES

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Primary hemangioma of bone is a relatively uncommon tumor. Prior to the roentgenological description by Hitzrot in 1917, the condition had been limited to a pathological entity. Bucy and Capp in 1930 collected forty-seven cases which presented clinical symptoms and which were definitely proved pathologically. In twelve of these cases, the vertebrae were involved; in eleven, the bones of the extremities; and in the remaining twenty-four, various other bones. Töpfer collected 257 cases of non-symptomatic primary hemangioma of bone during 2,154 autopsies. The vertebrae were involved in all cases and there were thirty-four instances of multiple lesions. The extremities were affected in only three cases.



FIG. 1

Case 1. Hemangioma of the humerus.

The present review of the literature is supplemental to that of Bucy and Capp. We were able to collect forty-nine references, since 1930, pertaining to primary hemangioma of bone. In this series of references there was one questionable case and sixteen proved cases of hemangioma. In three, the maxilla was affected; in one, the nasal cavity, the maxilla, and the base of the skull; in another, the hard palate, the pharynx and the larynx; and in five, the orbit. In the remaining seven, the vertebrae were involved. The questionable case was one of angioma of the skin with possible secondary involvement of the long bones.

general condition of the patient is of primary importance. The operation, therefore, should not be attempted in debilitated, actively febrile patients, or in those with profound organic disease which is likely to be aggravated by extensive surgery. In the same way, operations should be guardedly advocated in delicate, sensitive people and in those of poor emotional stability when there is reason to suppose that neither the idea nor the accomplished fact will be well borne. This being a purely elective operation, one should avoid every risk of thereby increasing the patient's burdens. Obviously there is no point in doing a synovectomy when the proliferation has progressed to the extent of severe cartilaginous ulceration and absorption as shown in the roentgenogram by a material reduction in the joint space. After so much damage has occurred, it is impossible to improve the mechanics of a joint by a synovectomy. It should be constantly remembered that the great purpose of synovectomy is to prevent extensive joint damage, and to this end the operation must be done early or at such time as it becomes clear that the process is not receding, that the exudate is too slowly resolving, or that proliferation continues in spite of all other therapeutic aids.

During the past fifteen years many surgeons have advocated the use of synovectomy in forms of arthritis other than the atrophic variety. J. S. Speed recommended the operation for traumatic arthritis, benign tumor of the knee joint, osteochondromatosis, and syphilitic synovitis. Bernstein added to this list hypertrophic arthritis, and Heyman qualified its use in this type by advising it in the presence of joint mice if secondary synovial changes occur. Skillern reported a good result from synovectomy in a case of hypertrophic villous arthritis accompanied by a well-marked osteo-arthritis. Krida reported the benefits resulting from synovectomy in two cases of intermittent hydrarthrosis of the knee joint. Besides these definitely specified types of lesion for which synovectomy has been advised, it is well known that many surgeons have applied it to the treatment of joint tuberculosis. It is desirable to examine critically these newer recommendations and to evaluate their probable usefulness on the basis of the theoretical grounds and the clinical results.

Several writers have concurred in Speed's advocacy of synovectomy for traumatic arthritis, and it is gratifying to observe that complete recovery has been the rule in all of these cases thus far reported. On theoretical grounds it appears to be logical to expect recovery following the removal of chronically inflamed synovial tissue which is swollen, oedematous, wrinkled into folds, and covered with hypertrophied villi and fatty tabs. Such a membrane has largely lost its functional capacity and, since in the purely traumatic type there is no contributing cause of constitutional origin, its removal ought to be followed by recovery. The clinical results thus far reported certainly bear out these ideas, and it may, therefore, be confidently said that chronic traumatic arthritis provides one of the major indications for synovectomy.

Benign tumor of the knee joint has been listed by several writers as a



FIG. 3

Hemangioma of the ulna. Duplicate of Case 849, Registry of Bone Sarcoma.

equal distribution in regard to sex. Three of the four patients gave a history of trauma,—two had had pathological fractures and the third had sustained a crushing injury.

The ages in the series of Bucy and Capp, including all sites of involvement, ranged from ten to seventy-six years; the average age was 37.36 years. Trauma occurred in three instances and a fracture in one. The series included twenty-four males, seventeen females, and six patients whose sex was unreported.

In Töpfer's autopsy findings, the percentage of females was 54.

ROENTGENOGRAPHIC FINDINGS

Haas and Codman emphasized the presence of small locules in lesions of small bones. Similarity between the roentgenographic findings of giant-cell tumor and hemangioma was observed. Pohl described a fine fibrillary framework within the individual locules. In some instances the cortex overlying the expanded portion of the tumor was destroyed.

Roentgenographic findings in primary hemangioma of bones of the extremities in the present series resemble those of bone cyst or giant-cell tumor. Figure 1 shows an expansile tumor extending from the epiphysis distally to involve one quarter of the shaft. The cortex, except for the point of fracture, is intact. The medulla and the replaced cortex are trabeculated. Several small punched-out areas can be seen distal to the lower border of the tumor. These areas are of importance because they indicate progression and are typical of an actively growing angiomatous lesion in any tissue. This phenomenon should be stressed in future observations of primary hemangioma of bone. Figure 2 is a roentgenogram of the same arm two years later. The original cyst has been curetted and is now healed, but there is progression of the lesion distally in the medullary cavity. The cavities formed may now be described as small locules. The walls of these locules possess a heavier framework than those of giant-cell tumors. When compared with the changes in Figure 3 (Case 849 of the Registry of Bone Sarcoma, which was also referred to the surgical pathological laboratory of the Johns Hopkins Hospital) one can see a great similarity. The framework of the locules in both instances is heavy and of diagnostic significance because this is not common to other tumors. The similarity between the roentgenogram



FIG. 4

Case 2. P. N. 57674. Hemangioma of the radius.



FIG. 5

Case 3. P. N. 54290. Hemangioma of the humerus.

of primary hemangioma and cystic lesions in the long bones is again emphasized by the changes shown in Figure 4. The tumor, which involves the distal two thirds of the radius, is expansile and lobulated. The lobules are fairly large, and the cortex is intact. There is a striking resemblance to a giant-cell tumor, but the extensive osseous involvement is suggestive of angioma. Figure 5 is a roentgenogram of a hemangioma of the upper end of the humerus. It is a typical picture of a cystic lesion in which a pathological fracture has occurred. It differs from the previous lesions in that the tumor is localized to a more restricted portion of the shaft and in the complete absence of lobules or locules. There is no tendency to expansion. A benign bone cyst is simulated. The fourth case studied is that of a malignant primary hemangioma of the os calcis, which closely resembles the roentgenographic changes, due to primary hemangioma, seen in the astragalus of Case 249 of the Registry of Bone Sarcoma (Bucy and Capp). The lesion in Figure 6 consists of numerous small lobules of various sizes. The lobules are ill defined, and the lesion has no tendency to expand. Here again, the changes are those of a cystic lesion.

It may be concluded that the roentgenographic changes of primary hemangioma of bones in the extremities are similar to those of benign giant-cell tumor or osteitis fibrosa cystica, but they may present several significant features. First, the lesion tends to progress and may be more extensive than those commonly found in the other cystic or expansile lesions under consideration. Second, the locules, when present, are smaller than the lobules of benign giant-cell tumor or benign bone cyst, and are bordered by a much heavier framework of osseous tissue.

## GROSS PATHOLOGY

The gross appearance, general consistency, and color of the pathological tissue varies. Case 1 was a capillary hemangioma. The surgeon found, at operation, that the cortex had become very thin. In places he could cut through the tissue with scissors, and there was evidence of a broken capsule which permitted the escape of fluid. The medullary cavity and part of the cortex were replaced by a cystic cavity containing a clear straw-colored fluid. The cavity walls contained no capsule, but a small amount of material resembling a blood clot was obtained on curettage. Similar changes were found in Case 2. The third case showed an interesting pathological picture. The specimen shown in Figure 7 was available for study. The pathologist, to whom the biopsy material had been submitted, made a diagnosis of sarcoma. The arm was dis-

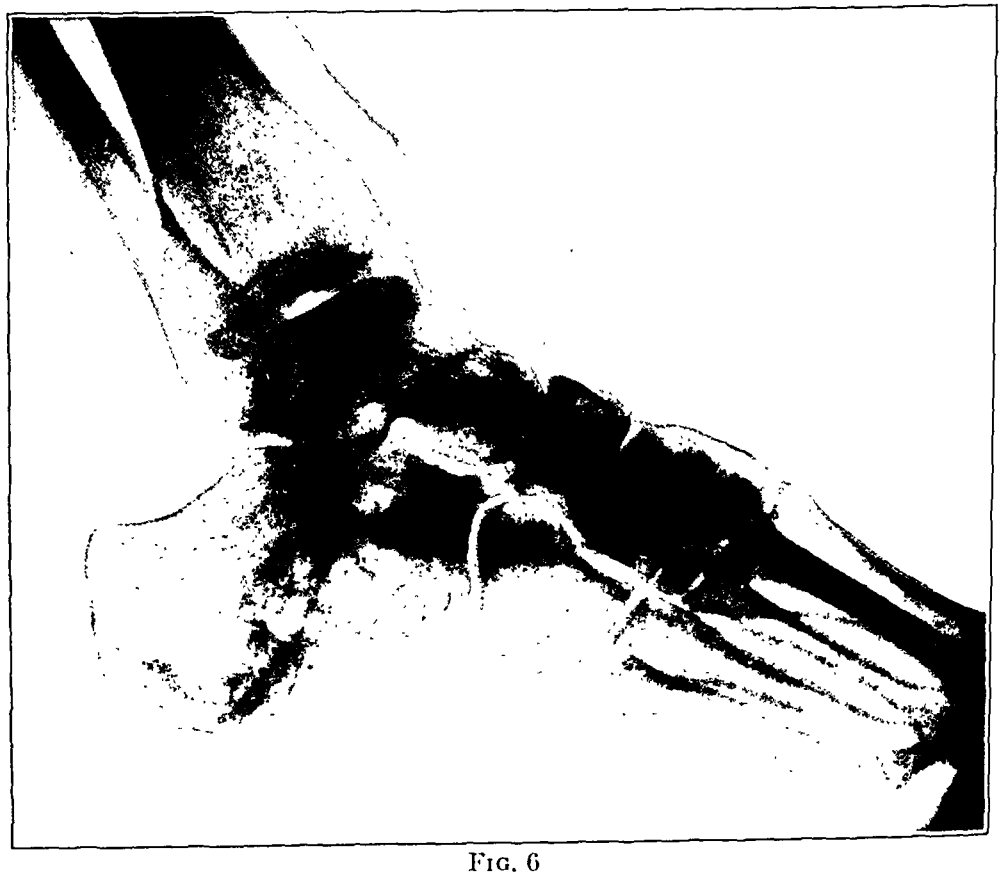


FIG. 6

Case 4. P. N. 37954. Angiosarcoma of the os calcis.

articulated at the shoulder joint. The tumor consisted of a mass about seven centimeters in diameter and was well circumscribed and surrounded by a definite wall of bone. The enclosed material was mucoid and red in color. It was grayish in spots and had the general appearance of angioma. In Case 4, an angiosarcoma, the surgeon, at operation, found a small bluish tumor attached and protruding through the periosteum of the os calcis. No attempt was made at the first operation to explore the bone. At the second operation, the calcaneum was found to be replaced in part by two cystic cavities which contained grayish-red granular material. Sufficient data are not available to permit us to determine whether the angioma had its origin in the bone proper or in the periosteum covering it.



FIG. 7

Photograph of gross specimen of angioblastoma of upper end of humerus. (See Fig. 5 for x-ray changes.)

Thus, primary hemangioma of bone gives rise to cystic cavities which contain no capsular lining. Like bone cysts, they may contain fluid or tumor tissue within the wall. The tumor material filling these cavities is apparently similar to the tissue of angiomatous tumors elsewhere.

## MICROSCOPIC FINDINGS

Hemangioma of bone presents various microscopic features. Kümmel and Rockemer described a case of hemangioma of the nose, maxillary cavity, and skull, which was of the capillary form. Phemister reported a case of capillary hemangioma involving the clavicle. No reference has been made to angioblastoma. The cases reported in the literature were for the most part of the cavernous type.

In our series there was a capillary hemangioma, a cavernous hemangioma, an angioblastoma, and an angiosarcoma. The section of the capillary hemangioma (Fig. 8) shows areas of hemorrhage between which can be seen capillaries with their single layers of endothelium and hyaline contents. The tissue contains large cystic cavernous spaces filled with

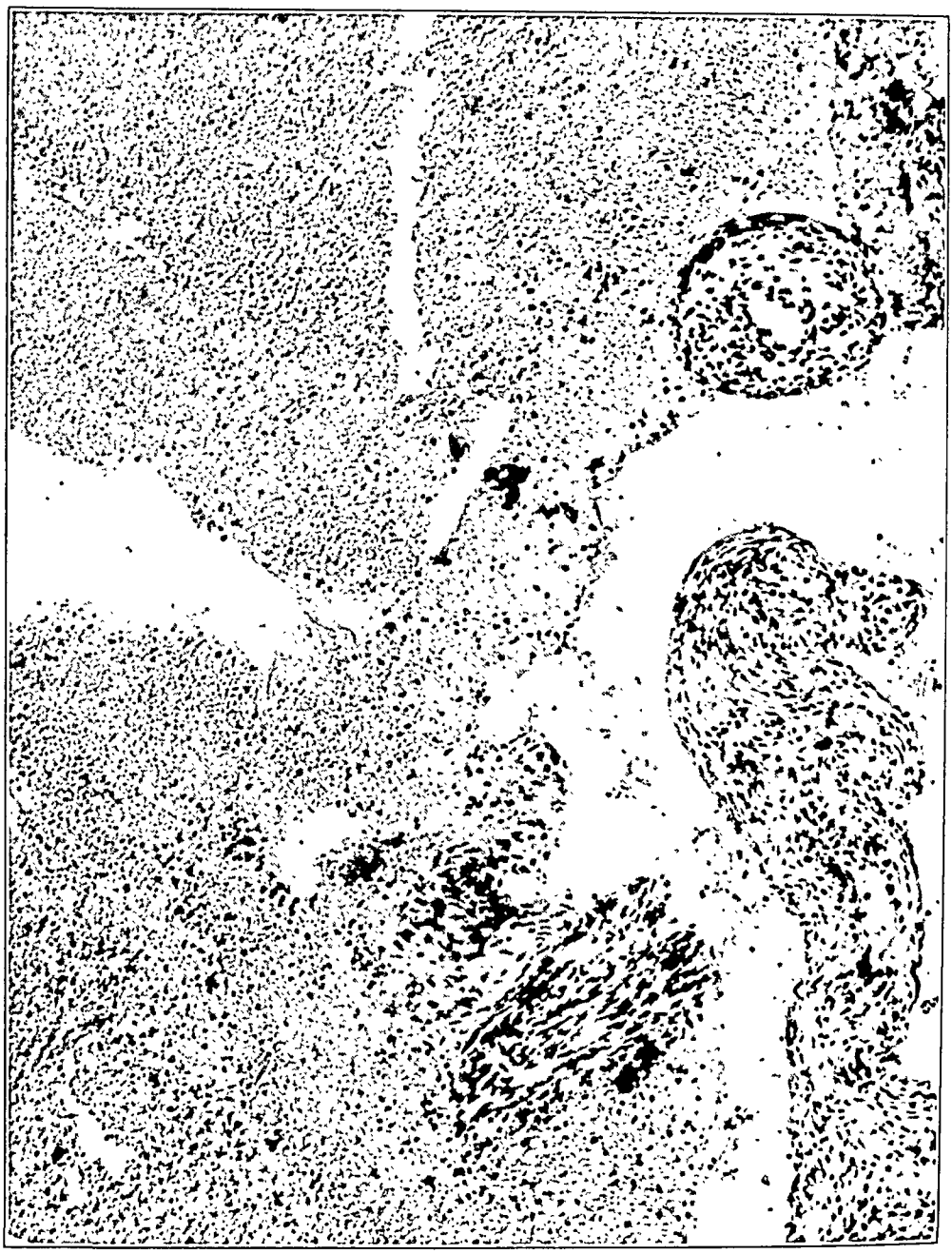


FIG. 8

Case 1. P. N. 52672. Capillary hemangioma of bone. (Low magnification.)

red blood cells and an occasional lymphocyte or polymorphonuclear leukocyte. The second case is a cavernous hemangioma (Fig. 9). It presents irregularly shaped sinuses which contain coagulated material. These sinuses are lined by endothelium. Definitely formed capillaries and stroma containing young fibroblasts are interspersed between the many channels. The case of angioblastoma (Fig. 10) is the first to be reported in bone. This tumor consists of tortuous tubules which lie in a fibrous stroma. These tubules for the most part contain a colloidlike material. An occasional small capillary can be seen. The fourth case is a malignant



FIG. 9

Case 2. P. N. 57674. Cavernous hemangioma of bone. (Low magnification.)

angioma (Fig. 11). It does not present the features of a Kaposi tumor, nor is it comparable to the so-called angio-endothelioma. The tissue consists of many small cavernous spaces lined by single rows of endothelial cells and containing a deeply staining material. Between these spaces are many small tightly packed endothelial cells which often contain a single centrally placed nucleus. The cells are uniform in size and are deeply stained. In this case, the patient died of metastasis.

## TREATMENT

Irradiation has thus far proved to be the most valuable method of treating primary hemangioma of bone. Complete cures have been reported in a number of instances. Case 1 of our series did not respond to irradiation. The value of curettement is questionable. Resection of bone has been reported in several cases and has proved to be an absolute means of cure. Further observations will be necessary before any specific recommendations can be offered.

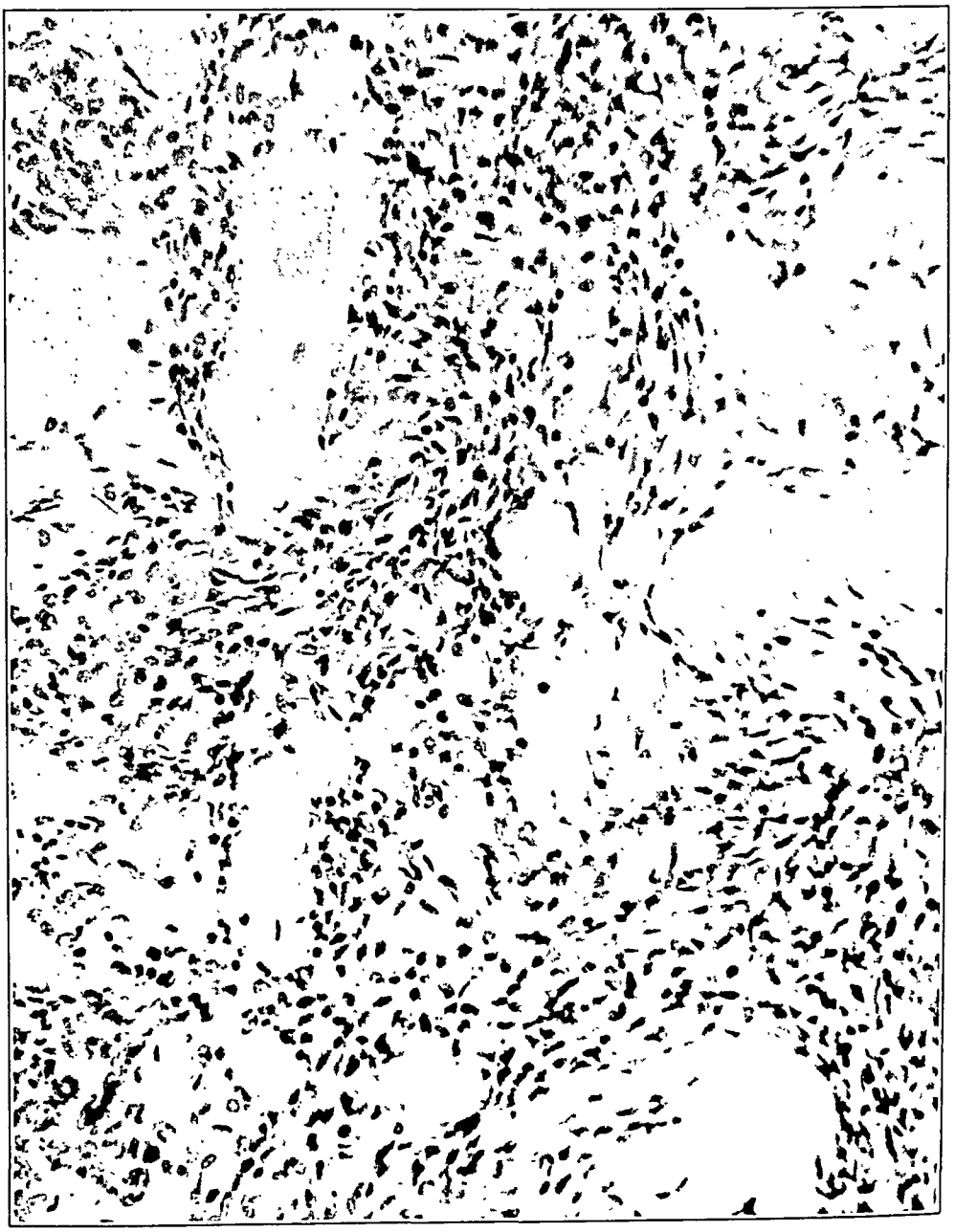


FIG. 10

Case 3. P. N. 54290. Angioblastoma of bone. (Low magnification.)

## CASE REPORTS

CASE 1. P. N. 52672, a white female, aged eight, fractured her left arm on November 8, 1933. The arm was in plaster splints for six weeks, and one week after the removal of the splints, was fractured again. (The roentgenographic findings have already been described.) An exploratory operation was performed in January 1934 by Dr. George E. Bennett. The area was irradiated with deep x-ray. The pathological diagnosis was capillary hemangioma. The lesion slowly progressed, and the arm was again fractured in 1935, which resulted in a second operation. The clinical course was uneventful until September 1937, at which time the patient sustained another fracture of the humerus below the previous site. A bone graft was implanted. Roentgenographic examinations, taken at frequent intervals beginning with the original injury in 1933, showed a steady progression of the lesion. (See Figure 2.) The condition is still uncured.

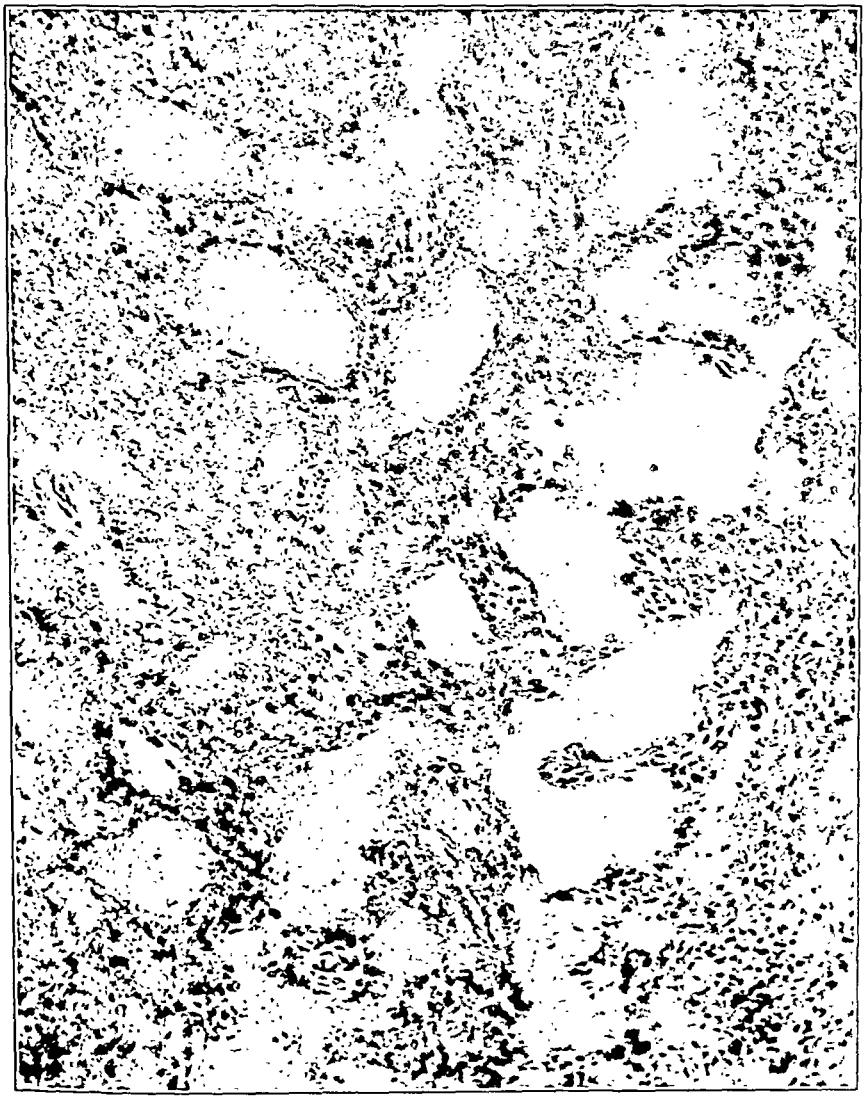


FIG. 11

Case 4. P. N. 37954. Angiosarcoma of bone. (Low magnification.)

CASE 2. P. N. 57674, a white male, aged ten, sustained a crushing injury to the left forearm two years previous to examination. The wrist had been placed in a splint for several weeks. Swelling, which began at the time of injury, had persisted and had become worse some weeks prior to the examination. Pain and disability had increased. (For details of the roentgenographic findings see previous description.) The lower end of the left radius was resected, leaving the epiphysis intact. A bone graft was inserted. The pathological diagnosis was cavernous hemangioma. No recurrence followed, and the patient has a fairly good, functioning wrist.

CASE 3. P. N. 54290, a white male, aged eleven, injured the right arm in May 1931. The clinical findings were those of a pathological fracture. The roentgenogram showed a fracture through a cystic lesion. The lesion was curetted, and a bone graft was inserted. The arm was again injured in July 1934. A biopsy was performed, and the diagnosis was sarcoma. The surgeon resected the right arm at the shoulder joint. A description of the gross specimen has been given. The final pathological diagnosis was angioblastoma. Our last follow-up examination in 1937 showed the patient to be well.

CASE 4. P. N. 37954, a white female, aged twenty, was admitted to the St. Luke's Hospital in July 1921, complaining of a mass over her ankle of ten months' duration. Examination revealed a cystic mass below the external malleolus and attached to the deep structures. The tumor was resected. The mass recurred five years later. Roentgenographic examination of the os calcis showed bone changes. An exploratory operation revealed an angiomatous tumor arising from the periosteum and involving the os calcis. Curettement of the os calcis was performed. The patient ultimately died of metastasis.

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# BONE BLOCK FOR PAINFUL HIPS *

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The purpose of this paper is to present our experience in the treatment of a common condition, that of painful hips, by a new procedure or, rather, a new application of a method already used in other parts of the body. We cannot say that we are reporting end results, although we have used this method for over six years, as the final results cannot be estimated for many more years to come. We are simply giving the information available at this time as to the results of this operation.

In March 1927, an extra-articular fusion was attempted in a case of tuberculosis of the hip, and failure resulted. The bone graft united to the side of the ilium, but failed to fuse on the trochanteric side, so that the bone graft acted as a block against the femur. The result was a movable hip with a large block of bone attached to the ilium on one side and impinging on the greater trochanter on the other. When the patient was allowed to walk, we were surprised to find that the pain had been relieved. Although the hip never fused, the pain was apparently permanently relieved. The last examination of the patient in October 1937, ten years after the operation, showed that he had a fair amount of painless motion.

We tried to explain the relief of symptoms by the fact that the bone graft was acting as a block against the trochanter, whereby some of the weight was carried on the greater trochanter through this bone. We began to wonder whether or not this operation, if done purposely instead of accidentally, would be successful in relieving pain in cases of painful tuberculous hip joints, without apparent activity, but we have never had the courage to do it for tuberculosis until recently.

We recalled this accidental experience in the spring of 1932 when a young woman, nineteen years of age, was admitted to our Service at the Kings County Hospital with a painful hip. The pain was so severe that the patient had been confined to bed for several weeks before being admitted. Roentgenographic examination of the hip revealed that she had a probable old untreated epiphyseal separation with the usual consequent hip deformity. Our problem was to relieve the pain without causing loss of use of the hip joint by an ankylosing operation, as we realized that an arthrodesis of the joint promised the only sure relief of symptoms. However, this seemed a radical procedure and meant a permanent deformity in a very young girl.

We decided to do purposely for this patient that which in other cases had occurred accidentally, so that we might take some of the weight from the joint proper and transfer it to the lower neck of the femur. In this way we might possibly relieve the pain. We also felt that if the operation

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 20, 1938.

proper indication for synovectomy and there would seem to be every reason for concurring in the self-evident rationale of this procedure. The author's own experience in this respect is too limited for a guide, and there is very little actual clinical material of this type in the literature.

Syphilitic synovitis is a condition in which synovectomy results in great benefit. Here is a chronic process constantly kept active by the parasites until grave destruction results in the joint. The removal of this diseased tissue and the simultaneous use of antisyphilitic treatment may be relied upon to terminate the process and to prevent its recurrence. Relapse may be expected, however, if the accompanying antisyphilitic treatment is inadequate in amount or is discontinued too soon. The writer's experience with this condition has been limited to cases of syphilitic arthritis of hereditary type.

The indications for synovectomy in chronic hypertrophic arthritis never have been clear to the author, and the literature does not satisfactorily set them forth. It would appear that little benefit could be expected in the ordinary cases of hypertrophic arthritis in which the process usually is confined to the articular margins where it seems to originate. In this disease it is difficult to conceive that synovial changes occur except as secondary effects, and, since hypertrophic arthritis is essentially a disease of middle or old age, the patients as a class are not generally suitable operative candidates. The writer has never encountered an example of hypertrophic arthritis that seemed to him to present the appropriate indications for synovectomy. This should not be taken as a dogmatic statement, but it does suggest that the patient should be very carefully examined and that one ought to be quite certain that there is present a sufficient degree of synovial involvement to warrant the belief that interference with it is justified. As Heyman has said, synovectomy may be helpful in hypertrophic arthritis with joint mice if secondary synovial changes occur.

In intermittent hydrarthrosis, as Krida has so well shown, there is every reason for resorting to synovectomy. In this disease the etiology is obscure, the prognosis is poor, and the process seems to center in the synovia. Under these circumstances, the operation is logically applicable, because it deals with the joint tissue primarily involved and, once the diseased membrane is removed, there is reason to expect that the new synovia may not be attacked by the same remote or local cause. Both from theoretical considerations and from the good results reported, it is reasonable to accept intermittent hydrarthrosis as an indication for synovectomy.

The temptation to do a synovectomy in tuberculous synovitis is strong, and it is easy to understand why a surgeon's hope that he may obviate the necessity for a resection or an arthrodesis can help to persuade him that it ought to be tried. Unfortunately, the abstract considerations are against this, because it would seem to be necessary to remove all of the infected tissues, and, as this is practically impossible, relapse is likely.

do this. The bone block limits abduction beyond a straight line and if the block is not sufficiently long to do so, the operation will be a failure, unless there is considerable shortening of the limb, in which case the block and the femur are brought close together when the pelvis tilts down toward the shorter limb on walking. Otherwise, no weight will be transmitted through the graft if the leg can go into abduction, although one of our patients has been completely relieved in spite of the fact that she has some abduction. Perhaps this explains why some of our patients were not completely relieved, as the grafts were not long enough. If the block is long enough to transmit the weight, it will grow in size as time goes on. If it is not long enough, it will atrophy. This happened in two of our cases. In our later efforts we have made sure that the graft is sufficiently long.

Thirteen of the seventeen patients were operated upon from two to five years ago. Only the cases of these thirteen will be described. Of these, eight have been relieved of pain; three have improved; one has not improved; and in one case the final result is unknown as we were unable to locate the patient for further check-up two years following the operation. However, she was seen about a year and a half after operation, at which time she walked with an excellent gait and was being treated with vaccines for joint pain in the hands, the wrists, the shoulders, and the neck.

Our results may be classified as "good", "fair", and "poor". By good, we mean that the pain has been relieved; by fair, the pain has been partially relieved; by poor, the pain persists as before operation. According to this classification, we have obtained good results in eight cases, fair results in three cases, poor results in one case, and the result is unknown in one.

## TECHNIQUE OF OPERATION

The hip area and the side of the ilium are exposed by a modified Smith-Petersen incision, bringing the upper arm of the incision well back along the crest of the ilium to expose the crest and the upper portion of the side of the ilium to permit the removal of a good-sized graft. This graft is taken in one of two directions, depending on the individual case. If there is no protrusion at the outer junction of the head and the acetabulum, a straight graft is used to stretch across the joint between the ilium and the trochanteric fossa or the greater trochanter. In some cases there is a mass of bone at the acetabulofemoral junction, so that a straight graft will not reach between these points. In that case, a curved graft is necessary. The straight graft is taken vertically on the side of the ilium, including half the crest and the outer table of the ilium, and is sufficiently long to reach between the points of contact which have been previously determined. The graft should be about one and a half inches wide (Fig. 1). If the curved graft is necessary, it is taken along the natural curve of the ilium, starting just behind the anterosuperior spine and going backward until the desired length can be removed (Fig. 2). When measuring

failed we could always fuse the joint to give relief. We have followed this case now for nearly six years and so far the patient has had no return of symptoms.

Encouraged by this result, we did a similar procedure on a boy suffering from an old apparently healed tuberculous lesion of the hip. In this case, the pain was probably due to poor mechanics in the joint. This patient was also relieved. We then felt that we might extend our indications to include other conditions with distortion and consequent poor hip-joint mechanics, particularly in cases of osteo-arthritis with severe pain in the hip, but with a good range of flexion and extension of the joint. However, in the arthritic cases with very little or no motion at the hip, we felt that a fusion was to be preferred to the bone block. In bilateral arthritis or tuberculosis of the hip with some motion present, the bone-block would be especially indicated, to avoid the severe disability of two stiff hips.

We have now performed the operation in seventeen cases: four cases of slipped epiphysis; three cases of congenital dislocation of the hip, where it was done instead of a shelf operation; four cases of tuberculosis; and six cases of hypertrophic arthritis. Not all of the patients have been completely relieved of pain, but, as a whole, the results have seemed very satisfactory to the patients and to ourselves. For practical purposes we may say that the operation has been done for arthritis of the hip, regardless of what may have caused the arthritis, as it is impossible in some cases to determine the exact cause. For example, it is very difficult in adult life to determine whether a distorted hip joint is the result of Perthes' disease, slipped epiphysis, trauma, or low-grade infection in childhood. One might think that with a good history the diagnosis should be simple, but many of these patients have a hazy memory of disability either in childhood or in early youth. In future cases of congenital dislocation of the hip, we shall probably not continue to have the graft act as a block, but we shall use the same type of graft as a shelf.

The rationale is difficult to explain, but it seems to us that the bone block apparently takes on some of the weight in walking, and thus relieves the weight-bearing joint surfaces. This theory is supported by the fact that the graft is essentially parallel with the neck of the femur, and it takes up the stress and strain of the neck, as evidenced by the growth of the transplant as time goes on. We feel that the graft would absorb if no stress were placed on it. This happened in only one of the cases, which was a failure. Our belief in this theory is further strengthened by the fact that in another case, where the graft fractured near the iliac attachment, union followed, and the transplanted bone has continued to grow and is now bigger than the original transplant.

All of these patients develop an adduction and flexion deformity. To us, this is an indication that abduction produces pain, and nature attempts to relieve this pain by bringing the leg into adduction by muscle spasm. This is a protective mechanism. The operation helps nature to

walk without any support. We decided that if pain should return a refusion operation was to be done.

We continued to watch the patient until 1933, during which time there was no recurrence of pain. The patient was again examined in October 1937, when we noted that he still had motion in flexion and extension and was able to walk without pain.

CASE 2. C. F., a white female, aged nineteen, unmarried, was admitted to the Kings County Hospital on April 9, 1932, complaining of pain in the right hip, which had begun seven months before admission. The pain had gradually increased in severity until about two weeks prior to admission, when she had been completely disabled and was forced to stay in bed for relief of pain.

A diagnosis of probable old slipped epiphysis was made, and a bone-block operation was performed on April 21, 1932. The patient was discharged on August 21, 1932. She was last seen on December 18, 1937, when she stated that she had had no pain since the operation. The result was good.

CASE 3. T. T., a white female, nine years of age, was admitted to the Long Island College Hospital on April 21, 1933, complaining of pain in the left hip and limping. She gave a history of having been treated for tuberculosis of the hip joint since the age of two. The relevant physical findings were that she had some draining sinuses from some submaxillary glands, and she walked with a marked limp on the left side with the foot in marked equinus. The left extremity showed two and a quarter inches of shortening. The greater trochanter was about two and a half inches above Nélaton's line. All motions of the hip were markedly restricted, except for flexion and extension in which there was a fair amount of motion.

Roentgenographic examination showed complete destruction of the head of the femur and almost complete destruction of the neck, and marked destruction of the acetabulum and of the adjoining ilium.

A diagnosis of tuberculosis of the joint was made, and a fusion was advised. An arthrodesis of the joint was done on April 25, 1933, by applying a large bone graft across the hip joint between the side of the ilium and the greater trochanter. The patient was discharged on June 21, 1933, wearing a plaster spica, with instructions to return to the Out-Patient Department for observation.

Roentgenographic examination on August 30, 1933, showed the graft to be in good position and apparently uniting. The cast was changed on September 25, 1933, and again on December 15, 1933. Roentgenograms again showed that the graft was in good position and apparently alive. The cast was removed on February 14, 1934, and a caliper brace was applied.

Notes made in the Out-Patient Department on July 23, 1934, state that the patient was walking with a caliper brace, apparently comfortable, and with a limp which seemed to be due to the shortening, but with a "rather remarkable range of motion in *all* directions.

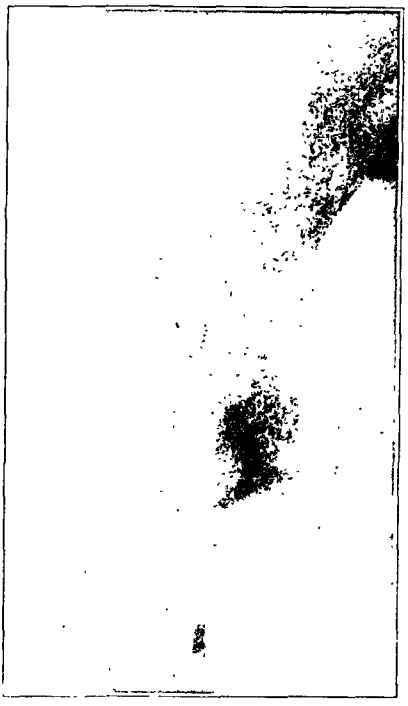


FIG. 3

Case 2. First case in which a bone block was done intentionally. This was a case of an old slipped epiphysis where a straight graft was used at operation on April 21, 1932. This roentgenogram was taken three years after operation.

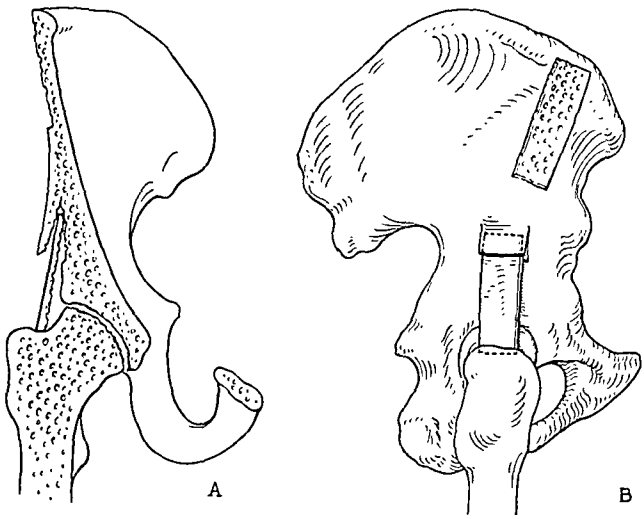



FIG. 1

Diagrammatic drawing showing the technique of the operation when a straight graft is used.

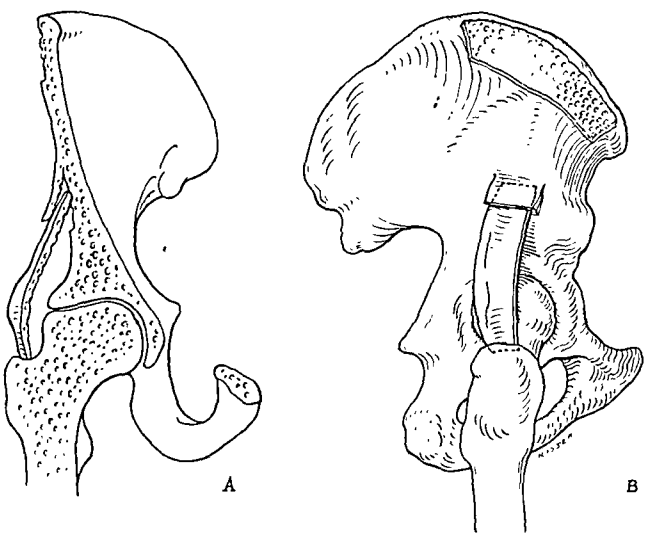



FIG. 2

Diagrammatic drawing showing the technique of the operation when a curved graft is used.

for the length of the graft, the surgeon should adduct the thigh, so that after the upper end of the graft is placed in a slot on the side of the ilium, the lower end is jammed tightly against the trochanter or the trochanteric fossa, as the thigh is abducted to the straight or neutral position. One must be sure not to place it in the slightest abduction. As the thigh is brought from the adduction to the neutral position, the graft is firmly pushed into the ilium. No sutures are necessary to hold the graft. A hip spica is then applied from the nipple line to the ankle. This is changed to a short spica after six or eight weeks, and the patient is allowed to walk with crutches. Complete weight-bearing is permitted as soon as roentgenographic examination shows union of the graft to the ilium, which is usually seen in from ten to twelve weeks.

Brief case histories of the patients, two or more years after operation, follow.

## CASE REPORTS

CASE 1. J. D., a white male, aged seventeen, in January 1926, applied for treatment for tuberculosis of the left hip at the Long Island College Hospital. He was given conservative treatment with traction and a plaster spica until March 4, 1927, when an extra-articular fusion of the hip was performed, followed by immobilization in plaster for six months. At the end of that time, roentgenograms showed that the upper end of the graft had united with the ilium, but the lower end had not united with the greater trochanter; good painless motion was present in flexion and in extension of the hip. As long as the patient had no subjective symptoms referable to the hip, he was permitted to

hip on weight-bearing, which had persisted to the date of admission. The pain had been relieved by rest.

Roentgenographic examination revealed complete absorption of the head of the femur and marked absorption of the acetabulum, but there was no apparent active disease. A diagnosis of probable tuberculosis was made, and a bone-block operation was performed on April 4, 1935. The patient was discharged on July 11, 1935.

She was last seen on December 18, 1937, when the hip was found to be stable. Abduction was limited. She was able to walk any distance without pain, including going up and down stairs.

CASE 7. L. R., a white female, aged eleven, was admitted to the Long Island College Hospital on April 5, 1935, complaining of pain in the left hip on walking. She gave a history of bilateral congenital dislocation of the hip. Both dislocations had been reduced, but the right had recurred. A bone-block operation was performed on April 9, 1935, and the patient was discharged on April 16, 1935.

She was last seen on November 22, 1937, when she walked with a considerable limp, but with no Trendelenberg symptom. The limp was due to seven-eighths of an inch of shortening. There was no pain on walking.

CASE 8. E. N., a white male, twenty-five years of age, was admitted to the Long Island College Hospital on June 26, 1935, complaining of intermittent pain in the left hip of seven or eight years' duration.

Roentgenographic examination showed marked destruction of the head of the femur and of the acetabulum of the left hip. The head was enlarged and flattened. The neck was broad and short. A diagnosis of probable old slipped epiphysis was made, and a bone-block operation was performed on July 23, 1935. The patient was discharged on October 30, 1935.



FIG. 5

Case 6. A straight graft was used for tuberculosis of the hip at operation on April 4, 1935. This roentgenogram was taken one year after operation.

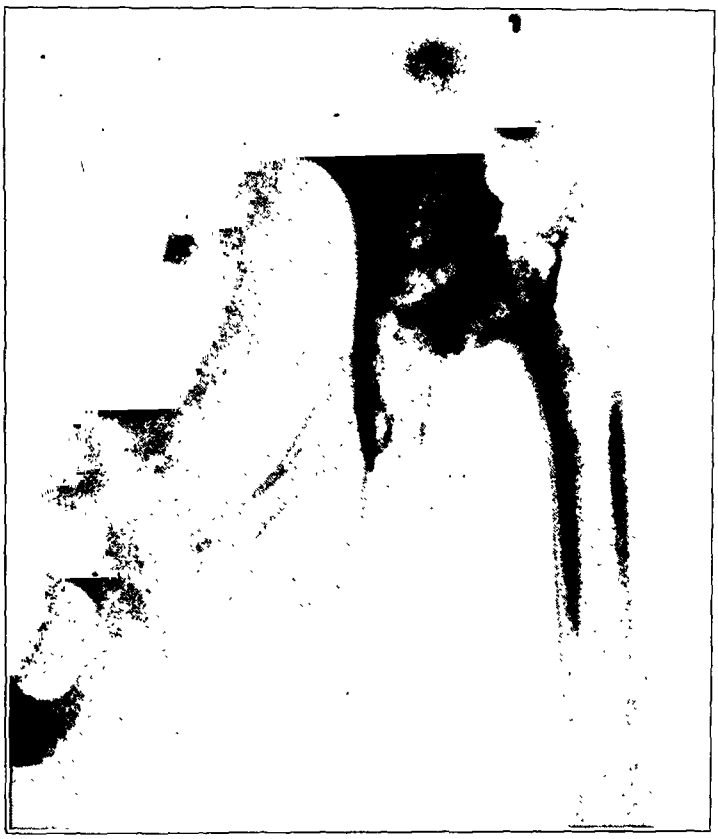


FIG. 4

Case 3. An accidental bone graft for tuberculosis of the left hip, following an attempt at fusion on April 25, 1933. This roentgenogram was taken about two years after operation.

Clinically she seems well; no loss of appetite; no pain." A roentgenogram taken at this time revealed that the graft had united firmly to the ilium, but not to the trochanter; thus the graft was acting as a block.

The patient was again admitted to the Hospital on January 27, 1936, this time for cervical glands and Pott's disease. At this time there was a painless and movable hip, but the shortening had increased to three and a half inches.

CASE 4. E. S., a white female, aged eleven, was admitted to the St. Giles Hospital on April 9, 1934, complaining of pain in the left hip on walking and of limping for the past few months. A diagnosis of congenital dislocation of the hip had been made and a closed operation had been performed at the Israel Zion Hospital, followed by immobilization in a plaster-of-Paris cast for sixteen months.

Roentgenographic examination showed a very shallow acetabulum. The head of the femur was almost entirely out of the acetabulum A diagnosis of congenital dislocation of the hip was made and a bone-block operation was performed in April 1934.

The patient was last seen on December 18, 1937, when abduction was equal but restricted on both sides. Five-eighths of an inch of shortening was present, but there was no telescoping, and the patient did not complain of pain on walking. The graft acted as a shelf.

CASE 5. J. W., a colored male, eighteen years of age, was admitted to the Kings County Hospital on July 2, 1934, complaining of pain in the left lower extremity and limping. Pain had been present for two months prior to admission. The patient gave a history of having had a slight limp since childhood.

Roentgenographic examination showed an old destructive lesion of the hip. The head of the femur was completely absorbed. A diagnosis of probable old tuberculosis of the hip was made. There was no evidence of activity. A bone-block operation was performed on July 26, 1934, and the patient was discharged on October 29, 1934.

The patient was last seen on February 8, 1935, at which time motion in flexion and in extension was good. He still complained of slight pain, but stated that he was satisfied with the result and would go through the same operation again if necessary.

CASE 6. I. K., a colored female, twenty-four years of age, unmarried, was admitted to the Kings County Hospital on March 26, 1935, with a history of having had trouble with the right hip since the age of nine. In 1934, the patient had experienced pain in the



FIG. 7

Case 10. This roentgenogram shows some absorption of the lower end of the graft. The patient had had a previous shelf operation for relief of pain, which failed. A bone-block operation was performed on August 22, 1935. The pain was not completely relieved, but the patient is well satisfied with the result. She can walk about ten blocks before pain develops. This roentgenogram was taken two years after operation.

years; then it had recurred, and another spica had been applied for six weeks. This had given relief, and she had been well for the following fifteen years, up to the time of her present admission.

A diagnosis of old epiphyseal separation of the left hip was made, and a plaster spica was applied on July 27, 1935. The patient was discharged to the Out-Patient Department on July 29, 1935.

She was readmitted on October 2, 1935, as immobilization in plaster gave her only temporary relief. When the plaster was removed, the pain recurred.



FIG. 8

Case 11. A bone-block operation was done on October 17, 1935. The roentgenogram shows that the lower end of the graft has been absorbed. This case was a complete failure. The patient had no relief of symptoms. The roentgenogram was taken two years after operation.

The patient was not seen again, but in November 1937 his doctor stated that the patient had been relieved of pain and was walking around comfortably.

CASE 9. F. P., a white female, thirty-two years of age, was admitted to the Kings County Hospital on August 13, 1935, complaining of pain in the left hip of three years' duration, which was aggravated on standing and on walking and was relieved by rest.

Roentgenographic examination showed hypertrophic arthritis of the left hip. A bone-block operation was performed on August 22, 1935, and the patient was discharged on September 29, 1935.

The patient was last seen on December 18, 1937, when she stated that before the operation she had been unable to walk more than one or two blocks without having severe pain in the hip, but she was then able to walk indefinitely and to work all day without any pain. Abduction was completely limited.

CASE 10. A. G., a white female, aged forty-eight, was admitted to the Kings County Hospital on August 19, 1935, complaining of pain in the left hip of fifteen years' duration. The pain had increased to the extent that just before admission it was almost impossible for her to walk. She gave a history of having fallen twenty years previously. A shelf operation had been performed elsewhere on this hip, without success. The present pain was aggravated by walking, but was relieved by rest. It was not relieved by physiotherapy.

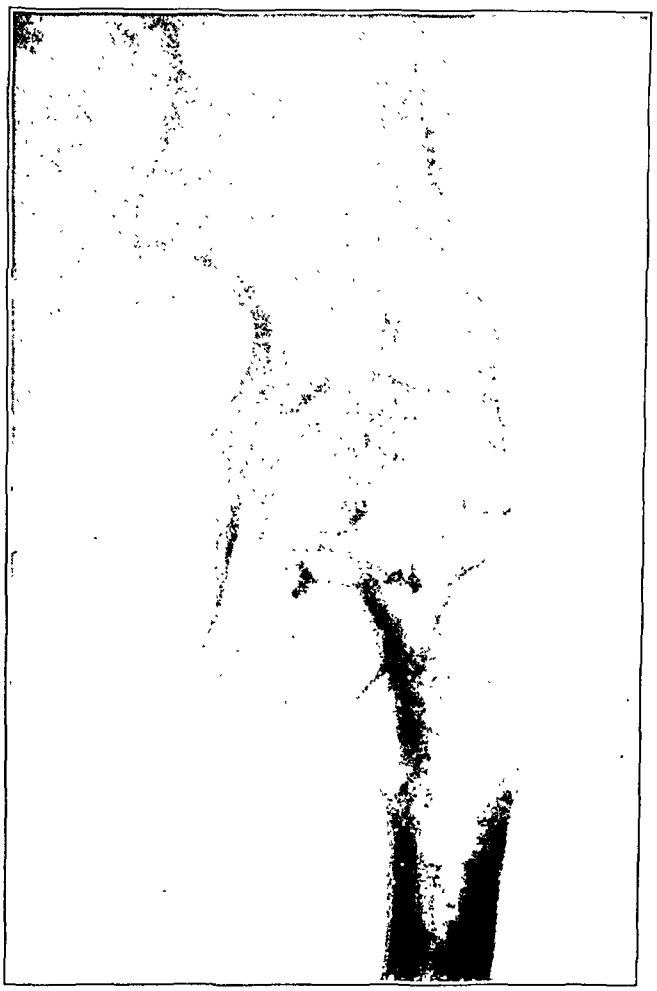


FIG. 6

Case 9. A curved graft was used in a bone-block operation on August 22, 1935, for hypertrophic arthritis of the hip. The pain was completely relieved. The patient does all her own housework. This roentgenogram was taken one and a half years after operation.

Roentgenographic examination showed the upper outer aspect of the head of the femur to be outside of the acetabulum. The head was flattened and mushroomed; the neck was broadened. A diagnosis of osteo-arthritis of the left hip was made, and a bone-block operation was performed on August 22, 1935. The patient was discharged on October 8, 1935.

The patient was last seen on December 18, 1937, when she stated that, although the pain had not completely disappeared, it was less than it had been prior to the operation, and she was able to walk longer distances than before. She also stated that her condition was still improving.

CASE 11. R. D., a white female, aged thirty-one, was admitted to the Long Island College Hospital on July 18, 1935, because of a painful left hip. She gave a history of having had trouble in that hip at the age of twelve, when it was treated with plaster spicas for six months. There had been relief of pain for four

The literature throws only a faint light on this subject, and in the few cases in which the author has tried this operation recurrences made it necessary later to do an arthrodesis. Barthélemy has reported two cases in detail and says that the operation is justified in certain cases, the most favorable type being synovitis with rice bodies of slow chronic nature, without temperature or crises of pain, and in a patient, preferably young, without other tuberculous lesions. Very recently Campbell has laid down the guiding principles for synovectomy in these words: "The type of joint in which the procedure is especially indicated is one in which there is extensive induration and fibrosis of the capsule, enlargement of the synovial villi, and persistent joint fluid. Such a joint may be caused by low-grade infection, osteochondromatosis, traumatic arthritis, benign tumors, and *synovial tuberculosis.*" So far as can be ascertained from the literature, it is apparent that some surgeons believe that there is a field of usefulness for synovectomy in tuberculosis of the synovia, and it is, therefore, not reasonable that the author's unsatisfactory experience should be accepted as a basis for entirely closing this door.

In addition to these conditions for which synovectomy has been advised by various authorities, the writer wishes to add two more types of synovial disease to the list. One of these is a form of chronic synovitis caused by local foreign-body irritation, and the other is a form of synovitis accompanied by an infiltration of the synovia by bone. Both of these conditions were encountered because confidence in the operation suggested its employment in these obscure cases although the usual clinical signs were not present.

Extended comment in regard to the foreign-body type of chronic synovitis is unnecessary. In this particular instance a sliver of wood had been lying free within the knee joint for a long period. The synovia presented the characteristic changes of swelling, oedema, and chronic inflammation, and there were numerous masses of free fibrin, in one of which the wooden splinter was found. The free masses were removed, and a conservative synovectomy was done.

The writer has never heard the term "synovitis ossificans", but the appearance of the synovial membrane in the second case, both in the roentgenogram and at operation, indicated that it was extensively infiltrated with actual bone. The disease appeared to follow a mild acute traumatic synovitis, and the process developed very slowly during a period of two years. The patient was a healthy young woman, and no cause was found except the trauma. The operation was made difficult by the density of the synovia. The patient made a complete recovery. The sections showed the calcific material to be actual bone. The pathological report follows:

"*Macroscopic Examination:* Several ragged pieces of synovial tissue are quite dense and show calcific changes in focal areas. Together they are six centimeters in diameter.

"*Microscopic Examination:* Sections show synovial membrane in which there are irregular areas of bone and cartilage formation. These appear to be actually heterotopic



FIG. 9

Case 15. Roentgenogram showing accidental fracture of the graft. This case is not described in the text.



FIG. 10

Case 15. The fracture has healed and the graft has increased in size. This roentgenogram was taken seven months after operation. The fact that the graft has united and has continued to live indicates that some stress is being placed upon it.

On the second admission, a bone-block operation was performed on October 17, 1935. The cast was removed on December 27, 1935, and roentgenographic examination at this time showed an apparently solid block. On December 31, 1935, the patient was allowed to walk with a support, and she was discharged on January 16, 1936.

When last examined, on September 21, 1937, she complained of pain in the hip when lying or sitting down. This pain was accompanied by marked stiffness, but after walking a short distance she was able to continue walking for about a mile without any recurrence of pain.

We have classified this case as a complete failure, although the pain is of a different character than it was before the operation. It is more that of a rheumatoid arthritis, which is strengthened by the fact that she now has pain in other joints for which her tonsils were removed in July 1937, to eliminate a possible focus of infection. The pain before operation was apparently continuous when walking, while the present pain occurs when the joint is inactive. The pain on walking has disappeared.

CASE 12. I. K., a white female, aged thirty-six, was admitted to the Kings County Hospital on November 1, 1935, complaining of pain in the right hip of ten years' duration, progressive in character. She gave a history of having injured the right hip at the age of seven.

Roentgenographic examination showed marked destruction of the hip joint with mushrooming and broadening of the head of the femur and shortening of the neck. The acetabulum was enlarged, with hypertrophic changes at the margins of the acetabulum. A diagnosis either of an old slipped epiphysis or of an old Perthes' disease was made. It was very difficult to tell which was the cause of the condition, and a bone-block operation was performed on November 14, 1935. The patient was discharged to the Out-Patient Department on December 28, 1935.

She was last seen in the Out-Patient Department on May 3, 1937, when she walked with a slight limp, although her gait was excellent. She was being treated with streptococcus vaccines for pain in the joints of the hands, the wrists, the shoulders, and the neck.

CASE 13. J. H., a white male, aged fifty-five, was admitted to the Kings County Hospital on March 25, 1936, complaining of pain in the right hip of two years' duration. The pain had increased in severity, so that just prior to admission the patient had been able to walk only a very short distance and had had to rest frequently to get relief. His past history was negative except for gonorrhoea thirty years previously.

A diagnosis of osteo-arthritis of the right hip was made, and a bone-block operation was performed on April 2, 1936. The patient was discharged on June 14, 1936.

This patient was last examined on September 21, 1937. He was then able to walk without pain and without any limp.

## CONCLUSIONS

Seventeen patients have been operated upon for various painful lesions of the hip, characterized by arthritic joint deformity with consequent poor mechanical function of that joint.

The majority of the patients have been either partially or completely relieved of pain. Four cases are too recent to warrant a final report: one is a complete failure.

It is our opinion that the pain is relieved because the graft takes on some of the weight in walking, producing what we might call an accessory hip joint, or because the abduction is limited by the bone block and thus impingement of the capsule is prevented.

# THE HEALING OF JOINT FRACTURES

## A Clinical and Experimental Study* †

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The question in regard to the ability of articular cartilage to regenerate after injury has long been a subject of controversy. Its answer would contribute greatly both to an understanding of symptomatology and to the rational treatment of fractures into joints. The reason for the uncertainty in this matter lies in the difficulty of obtaining suitable specimens for microscopic study. The surgeon hesitates to excise a portion of a fractured joint merely to satisfy his scientific curiosity, and the opportunity to inspect a joint several months after fracture does not often occur. Animal experiments, which permit the observation of the various stages of healing, have given conflicting results, depending on the species of the animals used and the type of injury inflicted. The present study of surgical specimens collected over a period of eight years has been supplemented with experiments on rabbits in which injuries to the articular cartilage were produced by the closed method and at operation.

To review adequately the steps in the development of our knowledge of the response of cartilage to injury would greatly exceed the bounds

TABLE I

Closed Experimental Fractures

| Rabbit No. | Joint | Observation Period (*Days*) | Appearance of Microscopic Sections |
|---|---|---|---|
| 142 | Elbow | 4 | Defect in cartilage filled with blood clot. |
| 146 | Elbow | 7 | Degeneration of comminuted cartilage. |
| 146 | Knee | 7 | No repair of fissure in cartilage. |
| 145 | Elbow | 14 | Intra-articular adhesion between humerus and ulna. |
| 141 | Elbow | 16 | Defect in cartilage filled with fibrous connective tissue. |
| 141 | Knee | 16 | Chipping of cartilage invaded by fibrous tissue. |
| 138 | Ankle | 23 | Degeneration of cartilage (traumatic arthritis). |
| 143 | Ankle | 31 | Defect in cartilage filled with embryonic connective tissue. |
| 143 | Elbow | 31 | Defect filled with atypical cartilage (? regeneration). |
| 139 | Elbow | 37 | Large loose fragment of cartilage (osteochondritis dissecans). |
| 137 | Elbow | 44 | Transition from connective tissue to new cartilage. |

* This work has been conducted under a grant from the Christine Breon Fund for Medical Research of the University of California.

† Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 20, 1938.

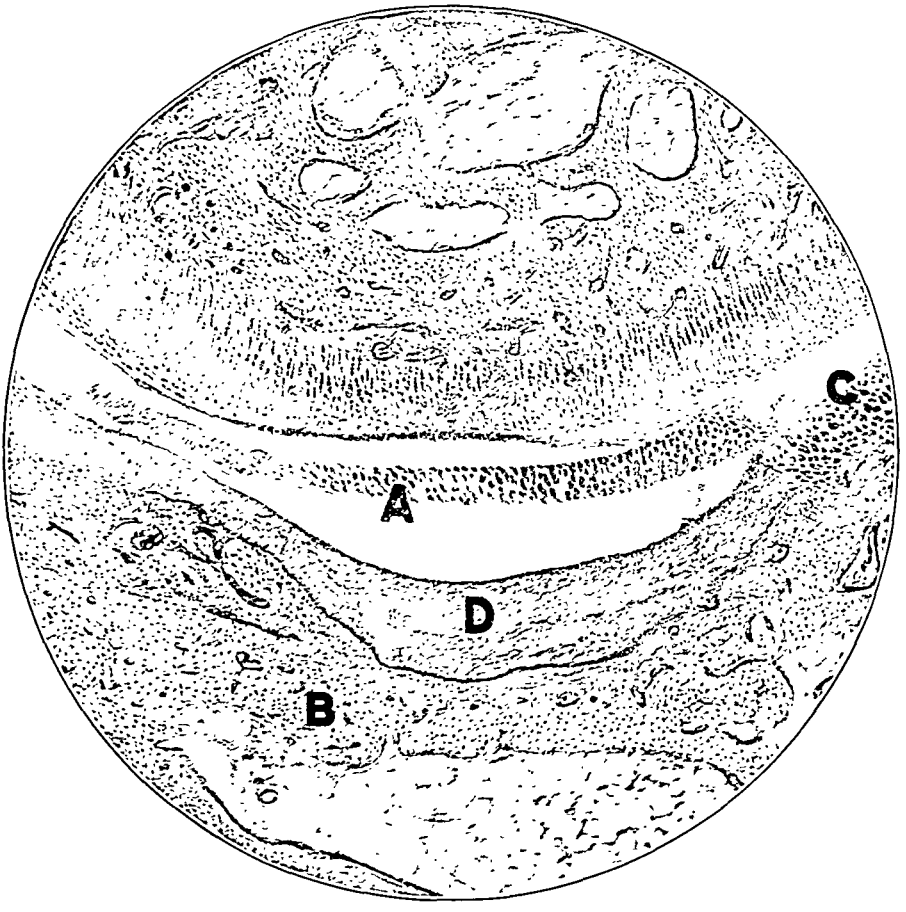



FIG. 1

Elbow of Rabbit 139, thirty-seven days after closed fracture. (Magnification × 35.)
*A:* Loose piece of cartilage in joint.
*B:* Bone (head of radius).
*C:* Normal cartilage on head of radius.
*D:* Defect filled with fibrous tissue.

of this paper. An excellent historical résumé has been given by Shands, who also has described the effects of the production of defects in the articular cartilages of the knees of dogs. Regenerative changes pass through successive stages of fibrin, granulation tissue, and connective tissue, which is converted into fibrocartilage and finally into new hyaline cartilage. In a similar manner, Key produced a traumatic arthritis in the knees of adult rabbits by the removal of a small area of articular cartilage. The defects were healed by the metaplasia of callus into hyaline cartilage, or by the growth of connective tissue. Haas observed the regeneration of the costal cartilages of rabbits which occurred by a direct proliferation of all the layers of the perichondrium beneath the outer fibrous tissue. A series of studies of articular injuries leading to chronic arthritis have been reported by Bennett and Bauer. They pro-

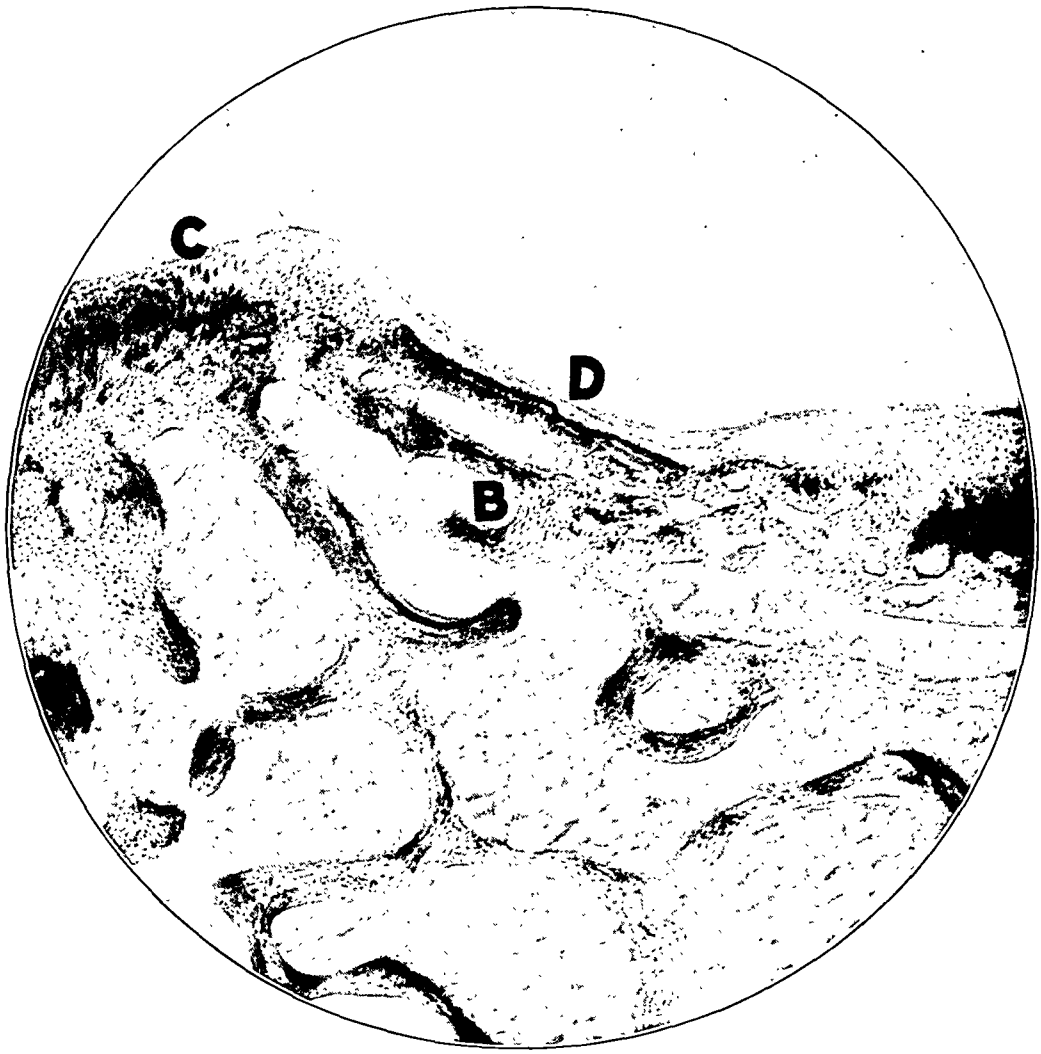



FIG. 2

Elbow of Rabbit 182, thirty-two days after open fracture. (Magnification × 35.)
*B:* Bone (condyle of humerus).
*C:* Normal cartilage.
*D:* Defect in cartilage filled with fibrous tissue.

duced defects in the cartilage of the patellar surfaces of the femora of dogs. Microscopic observations, made by sacrificing the animals at different periods from four to twenty-eight weeks after the operation, showed only infrequent and incomplete regeneration of the hyaline cartilage. The author has been unable to find any reports dealing with the healing of articular cartilage following fractures in man.

## METHODS AND RESULTS

In the interest of brevity and clarity, it seems best to outline the experiments and the clinical material to be presented, to tabulate the observations made, and to show a few typical specimens. The experiments fall into three groups, and were made on half-grown and adult rabbits. The clinical material comprises a fourth group. Photomicrographs are shown to illustrate the various stages of healing.

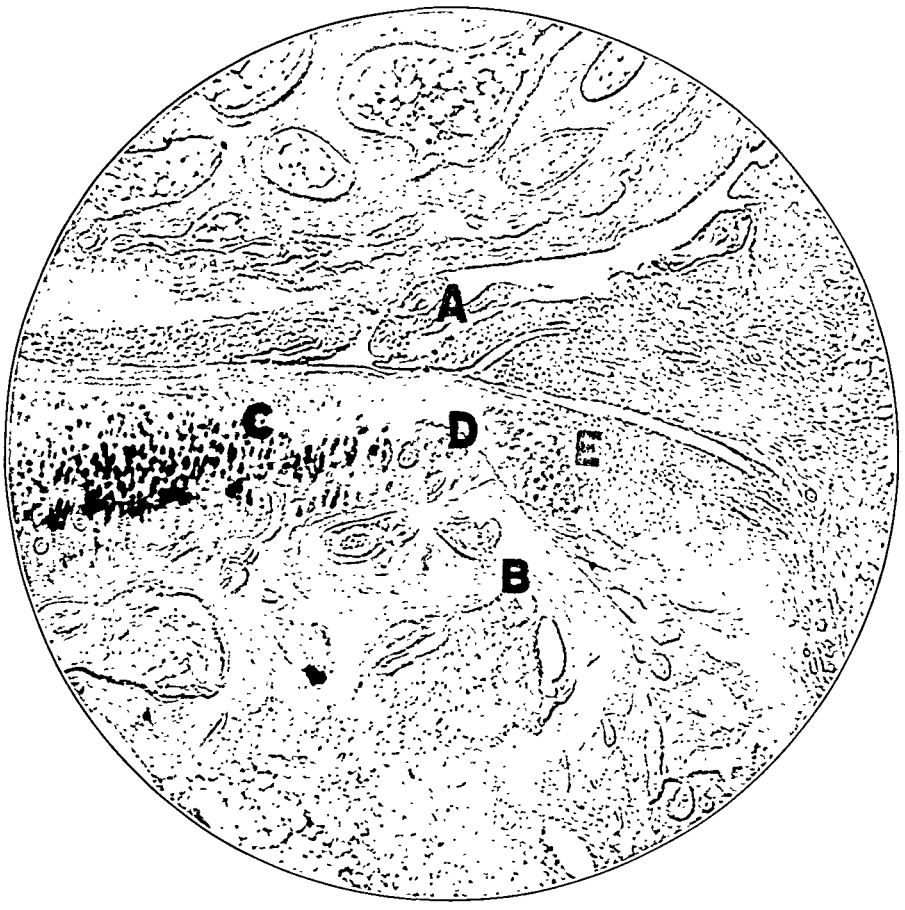



FIG. 3

Elbow of Rabbit 198, fifty-six days after open fracture. Immobilized for six weeks after fracture. (Magnification × 80.)

*A*: Adhesion across joint space.
*B*: Bone (condyle of humerus).
*C*: Normal cartilage.
*D*: Edge of defect in cartilage.
*E*: Metaplasia of fibrous tissue into cartilage.

### *Group A*

Fractures were produced in the joints of rabbits by allowing a weight to fall on the limbs which were stretched over a block. The character of the fractures was determined by roentgenographic examination, and the animals were killed at various periods after the fractures. Microscopic sections of the eleven specimens, which included the entire joint, were prepared by the celloidin method and were stained with hematoxylin and eosin. A list of experiments and results is given in Table I.

### *Group B*

A wedge-shaped defect, measuring three millimeters in width and extending into the subchondral bone, was made in the articular surface

TABLE II

OPEN ELBOW FRACTURES TREATED BY CAST

| Rabbit No. | Observation Period (*Days*) | Appearance of Microscopic Sections |
|---|---|---|
| 185 | 7 | Early callus restoring bone; no regeneration of cartilage. |
| 192 | 14 | Adhesion across joint; early regeneration of bone, but none of cartilage. |
| 195 | 29 | Adhesion across joint; regeneration of bone, but none of cartilage. |
| 196 | 41 | Adhesion; transition from cartilage into fibrous tissue filling defect. |
| 198 | 56 | Adhesion; nest of cartilage cells formed from connective-tissue cells in defect. |
| 209 | 70 | Adhesion; degeneration of cartilage at edge of defect; traumatic arthritis. |
| 210 | 72 | Thin layer of new bone covered with synovia, no regeneration of cartilage. |
| 211 | 89 | Adhesion; fibrous tissue replacing cartilage on surface of defect. |
| 212 | 108 | Fibrous tissue in defect being transformed into cartillage. |

of the lower end of the humerus at operation. The nine limbs included in this group were immobilized for about six weeks, or until the end of the

TABLE III

OPEN ELBOW FRACTURES TREATED WITHOUT CAST

| Rabbit No. | Observation Period (*Days*) | Appearance of Microscopic Sections |
|---|---|---|
| 180 | 7 | Early callus; fibrin in defect; no repair of cartilage. |
| 213 | 16 | Infected; adhesion across joint, plasma cells in cartilage defect. |
| 214 | 16 | Decolorized cartilage at edge of defect, with no repair. |
| 178 | 18 | Infected; defect filled with chronic granulation tissue; no repair. |
| 177 | 21 | No repair of punched-out area of cartilage. |
| 179 | 22 | Small defect with fibrous tissue lining base, but no repair of cartilage. |
| 181 | 26 | Floor of defect formed of dead bone; no repair of cartilage. |
| 182 | 32 | Floor of defect composed of thin layer of fibrous tissue on newly formed bone. |
| 176 | 39 | Defect in cartilage repaired with cartilage having no basal layer. |
| 215 | 56 | New bone covered with fibrous tissue on surface of which is synovia. |
| 216 | 73 | No regeneration of bone or cartilage of defect. |
| 183 | 96 | Atypical cartilage in defect: cells in transition from osteoblasts to cartilage. |

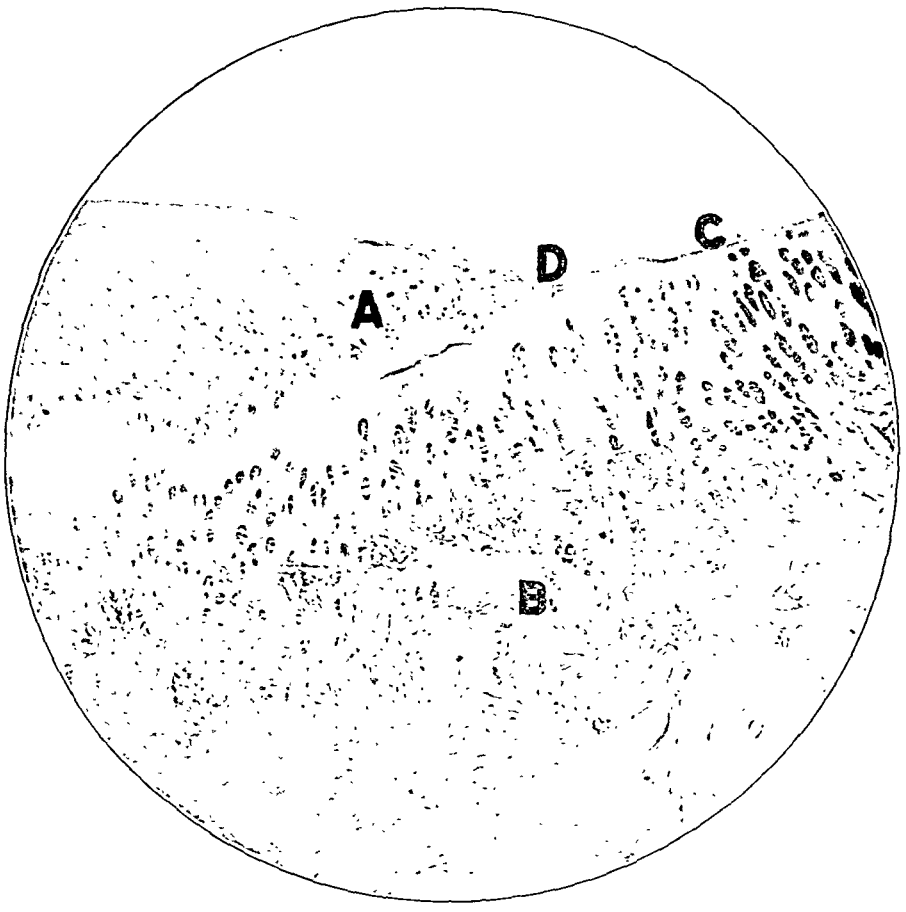



FIG. 4

Elbow of Rabbit 212, 108 days after open fracture. Immobilized for six weeks after fracture. (Magnification × 100.)

*A:* Fibrous tissue, showing metaplasia into hyaline cartilage.
*B:* Subchondral bone.
*C:* Normal cartilage.
*D:* Edge of defect in cartilage.

experiment, by means of a plaster cast. The entire joint was sectioned and was studied both for the repair of the cartilage and for the development of intra-articular adhesions. The results are shown in Table II.

*Group C*

In the twelve experiments of this group, the procedure was the same as in the previous group, but no form of immobilization was used. The results are summarized in Table III.

*Group D*

The clinical material consisted of twenty-eight specimens of cartilage and subchondral bone which were removed from patients at operation after fractures extending through the articular cartilage. These specimens had been collected over a period of eight years with the present

TABLE IV

SUMMARY OF TWENTY-EIGHT CLINICAL CASES

| Case No. | Bone | Duration of Injury | Appearance of Microscopic Sections |
|---|---|---|---|
| 1 | Head of radius | 5 days | Stripping away of hyaline cartilage; fissure. |
| 2 | Head of radius | 4 weeks | No healing of fissure through hyaline cartilage. |
| 3 | Head of radius | 9 weeks | Roughening of surface of hyaline cartilage; no regeneration. |
| 4 | Head of radius | 6 months | Replacement of fractured edge of cartilage by fibrous tissue. |
| 5 | Head of radius | 1 year | No regeneration of several large fissures through cartilage. |
| 6 | Head of radius | 6 years | Eburnation of bone at base of cartilage defects. |
| 7 | Carpal navicular | 1 hour | Chipping of superficial layers of hyaline cartilage. |
| 8 | Carpal navicular | 7 months | Fibrous union of bone; no union or repair of cartilage. |
| 9 | Carpal navicular | 1 year | Unhealed fissure in hyaline cartilage with fibrous edge. |
| 10 | Carpal navicular | 18 months | Devitalization of entire fragment of bone and cartilage; no repair. |
| 11 | Carpal navicular | 28 years | Degeneration of cartilage; metaplasia from connective tissue to cartilage. |
| 12 | Astragalus | 8 days | Death of nuclei of cartilage and bone; no regeneration. |
| 13 | Astragalus | 2 weeks | Fractured edge of cartilage and bone; no regeneration. |
| 14 | Astragalus | 67 days | Hyaline cartilage partly torn off at calcified zone; no repair. |
| 15 | Calcaneocuboid | 6 months | Cartilage invaded and covered by connective tissue from bone. |
| 16 | Calcaneocuboid | 11 months | After arthrodesis. Mixture of hyaline cartilage and fibrous tissue. |
| 17 | Carpal lunate | 4 months | Kienböck's disease. Deep fissures in cartilage; fibrous degeneration. |
| 18 | Carpal lunate | 16 months | Kienböck's disease. Desquamation of surface of cartilage; no repair. |
| 19 | Carpal lunate | Uncertain | Kienböck's disease. Irregular new cartilage under old fissured cartilage. |
| 20 | Carpal lunate | Uncertain | Kienböck's disease. Degenerating fringes of hyaline cartilage. |
| 21 | Femoral condyle | 20 days | Degenerating cartilage with fissure on surface; no repair. |
| 22 | Femoral condyle | 10 weeks | Osteochondritis dissecans. Fissure in cartilage; no repair. |
| 23 | Femoral condyle | 3 years | Osteochondritis dissecans. No repair of fissure in cartilage. |
| 24 | Femoral condyle | 5 years | Charcot's joint. Areas of cartilage replaced by fibrous tissue. |
| 25 | Patella | 20 days | Separation of cartilage from bone; fissure on surface; no repair. |
| 26 | Head of humerus | 10 weeks | Fissure through cartilage and bone; faint nuclei; no repair. |
| 27 | Head of femur | 3 months | Bone viable; fibrous tissue between bone and cartilage; no repair. |
| 28 | Head of ulna | 13 months | Extensive degeneration of hyaline cartilage; no repair. |

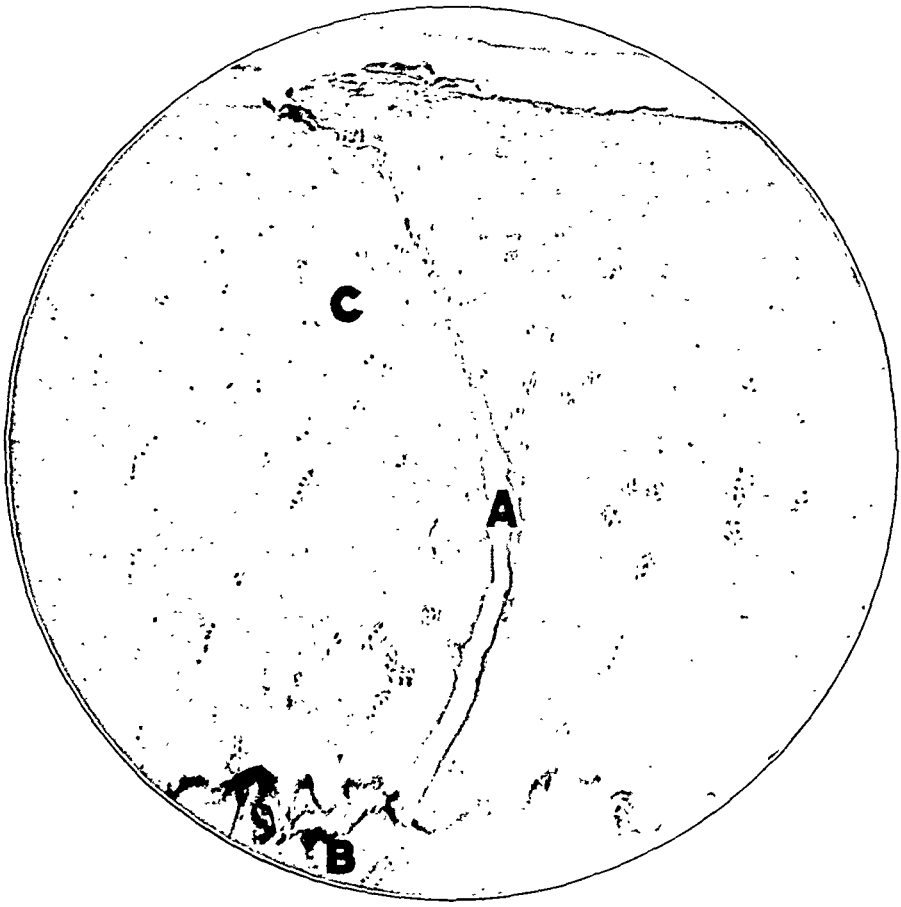



FIG. 5

Head of radius of Case 2, four weeks after fracture. (Magnification × 100.)
*A:* Fissure extending through hyaline cartilage, with no attempt at repair.
*B:* Subchondral bone into which fissure extends.
*C:* Hyaline cartilage.

problem in mind. A description of the microscopic sections is given in Table IV.

## DISCUSSION

The results of the various studies here reported may be discussed briefly. The observation periods in eleven closed fractures of certain joints of rabbits ranged from four days to forty-four days. After two weeks, the defects in the articular cartilage were filled by an invasion of fibrous connective tissue from the subchondral bone. Beginning about one month after injury, traces of fibrocartilage appeared in the connective tissue. The preexisting articular cartilage played no part in this regeneration.

Two groups of experiments were performed by the removal of a wedge of cartilage and bone from the lower end of the humerus. In the twelve rabbits without immobilization, the observation period ranged

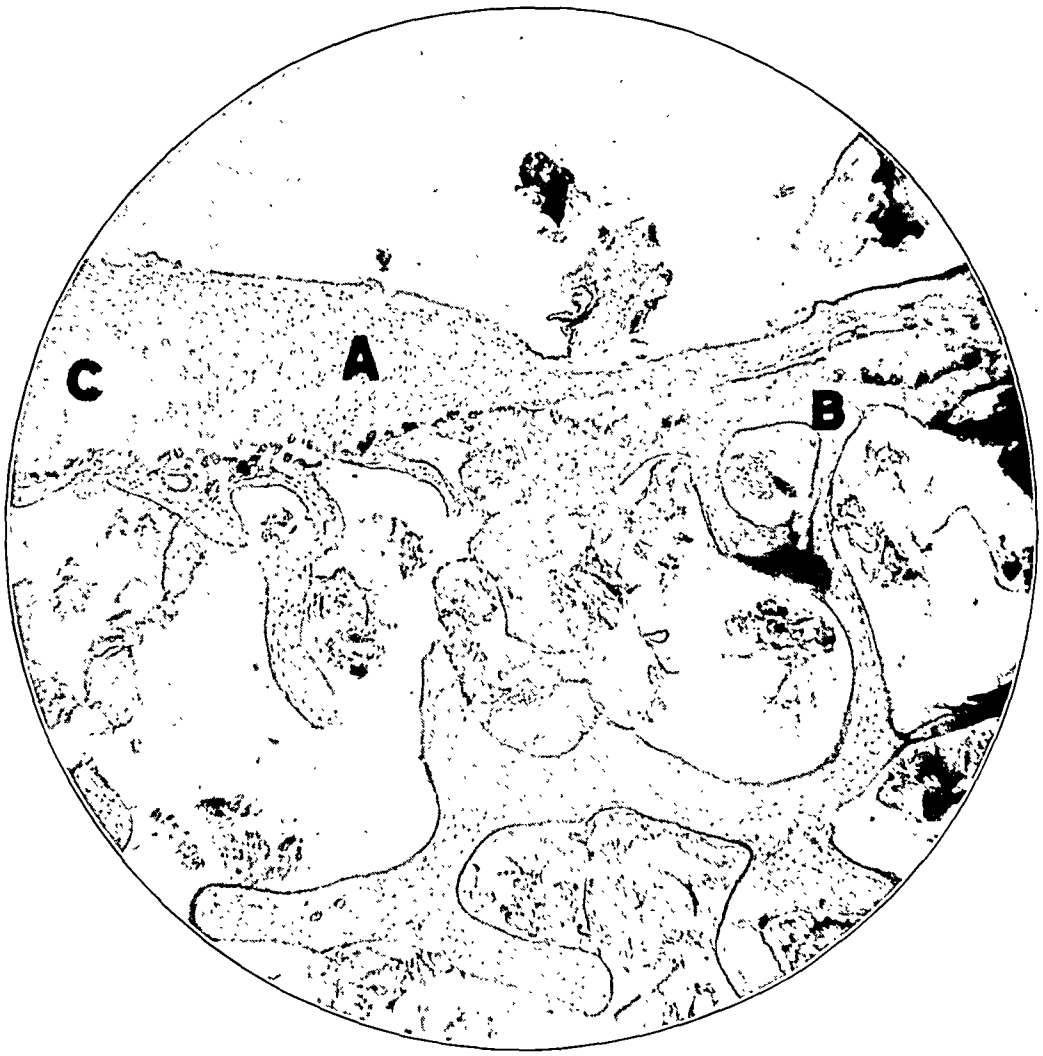



FIG. 6

Head of radius of Case 6, six years after fracture. (Magnification × 40.)
*A:* Fibrous tissue replacing hyaline cartilage.
*B:* Eburnated subchondral bone.
*C:* Normal hyaline cartilage.

from seven to ninety-six days. In only one instance was an intra-articular adhesion found to bridge the elbow joint. The bone defect regenerated rapidly, but was covered with a thin layer of fibrous tissue in most cases. In the oldest fracture, small areas of fibrocartilage were found in the connective tissue. One specimen, thirty-nine days after operation, showed a restoration of the defect with a layer of hyaline cartilage which differed from normal cartilage only in the absence of a basal deeply staining layer.

The nine joints which had been immobilized after creation of a defect were observed from seven to 108 days. In two-thirds of these joints, fibrous adhesions were found extending between the articular surfaces of the humerus and the ulna. This finding would seem to demonstrate the importance of early motion in the treatment of fractures which involve joints. In this group also there were several instances of degener-

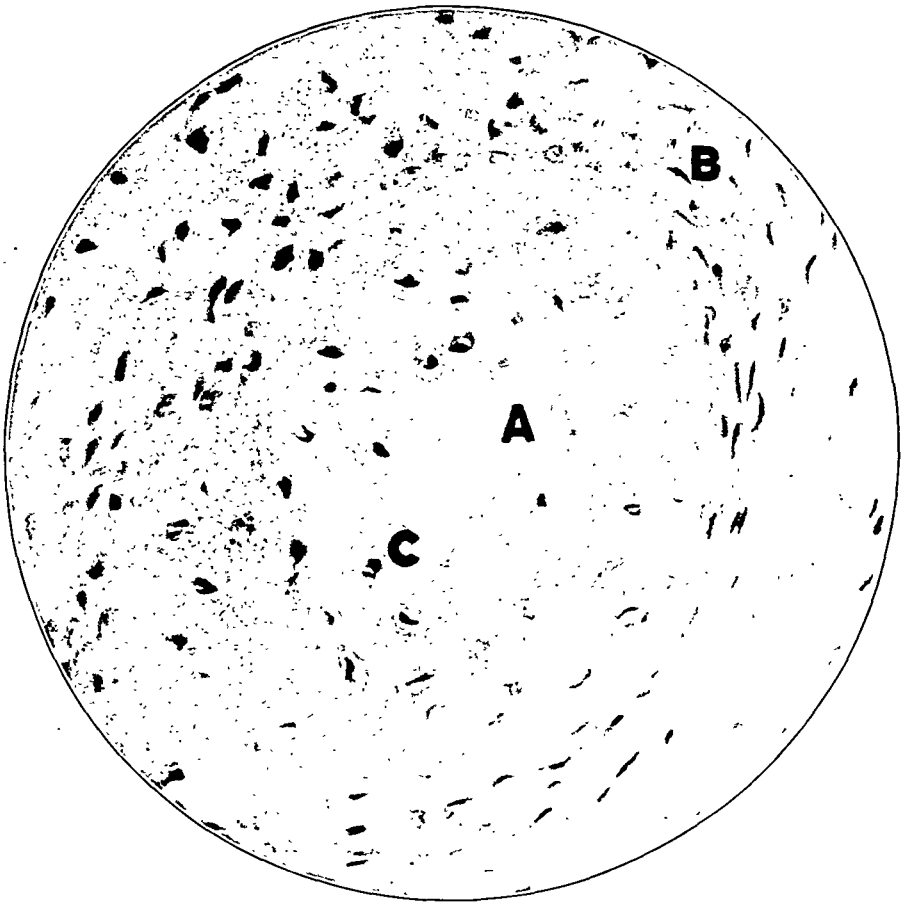



FIG. 7

Degenerated carpal navicular of Case 11, twenty-eight years after fracture. (Magnification × 500.)
*A:* Hyaline matrix.
*B:* Embryonic type of connective tissue.
*C:* Cartilage cell.

ation of the articular surface of the ulna in which no defect had been made. Repair of the defects, as in the preceding experiments, took place by the production of a layer of fibrous tissue on the newly formed bone. In the animal with the longest observation period (108 days), one can see the metaplasia of this fibrous tissue into hyaline cartilage.

The twenty-eight surgical specimens were obtained from patients suffering from a wide variety of articular injuries, which ranged in duration from five days to twenty-eight years. In contrast to the results observed in experimental animals, these clinical cases were almost without exception characterized by an absence of any evidence of regeneration of the cartilage. The only instances of metaplasia of connective tissue into hyaline cartilage were observed in two carpal bones affected by degenerative changes of many years' duration, and in a tarsal joint which had been subjected to an incomplete arthrodesing operation eleven months previously.

bone. There is a moderate chronic inflammatory reaction with considerable fibrosis. There are no granulomata.

"*Pathological Diagnosis:* Chronic ossifying synovitis."

Goldthwait mentions that in one of his early cases "a calcareous degeneration was found, and in the membrane there were numerous calcareous bodies, varying in size from the head of a pin to a good-sized pea, which, on section, showed true cartilage and bone cells".

The technique of synovectomy presents certain important features which ought to be constantly kept in mind. The first of these relates to its usefulness in any of the joints of the extremities. The customary attitude that the operation is confined to the knee joint is unfortunate. Excellent results have been obtained in the wrists, the elbow, the ankle, the interphalangeal and acromioclavicular joints, and the sternoclavicular joint. In fact, it is in some of these smaller joints that the end results have been most successful, and it is quite a satisfaction to the author that the first synovectomy which he did was in the metacarpophalangeal joint of a thumb, and this was in 1911. The patient, suffering at the time from an atrophic arthritis, was seen fifteen years later, at which time the operated joint had good function.

The approach to a joint for the purpose of synovectomy should be through the extensor surface in all instances, usually by way of a longitudinal incision. A single incision is preferable; multiple incisions are to be avoided unless there are special indications for them. The split patellar incision for the knee offers no material advantage over the median incision along the quadriceps tendon, the inner border of the patella, and the patellar tendon.

The extent of the synovial removal is a difficult matter to outline. The object is to do as little as will assure the needed benefits. It seems to be a mistake to do a complete synovectomy of the anterior or extensor compartments in every instance. It is assumed that no one tries to be so thorough as to attempt both the extensor and the flexor sides at once. Rarely may it be necessary to attack the flexor aspect of the knee when a communicating popliteal bursa is especially involved. Naturally, in tuberculosis the dissection should be as complete as possible and perhaps, too, in benign tumors and in syphilis, but in atrophic, hypertrophic, and traumatic arthritis it is probable that the best results are achieved by restricting the procedure to the most extensively involved portions. In other words, a complete block dissection is not always needed, and in atrophic arthritis especially the writer is inclined to believe that the full benefits and a lessening in the risk of postoperative fibrosis follow the removal of sections at intervals. After all, the improvement in the local circulation from this procedure may reasonably be expected to promote the resolution of the less organized exudate. Apparently this occurs in those cases in which only the extensor portion of the synovia is operated upon and improvement follows in the flexor portions.

Hard and fast rules concerning postoperative drainage and im-

# AN OPERATIVE TECHNIQUE FOR HALLUX VALGUS

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The operative procedure for the correction of hallux valgus which is herewith presented has been devised to utilize the tendon of the extensor hallucis longus as a direct antagonist to the oblique and transverse heads of the adductor hallucis muscles. This is done by translocating the long extensor of the great toe medially and passing it through a tunnel made by imbricating the now redundant capsule of the first metatarsophalangeal joint. The redundancy is resultant from the removal of the bony excrescence of the metatarsal head.

Thus, by reversing the bowstring (extensor hallucis longus tendon) from its previous position to its new site, medially, the chances for recurrences are at a minimum. Furthermore, the articular cartilage of the first metatarsophalangeal joint is undisturbed.

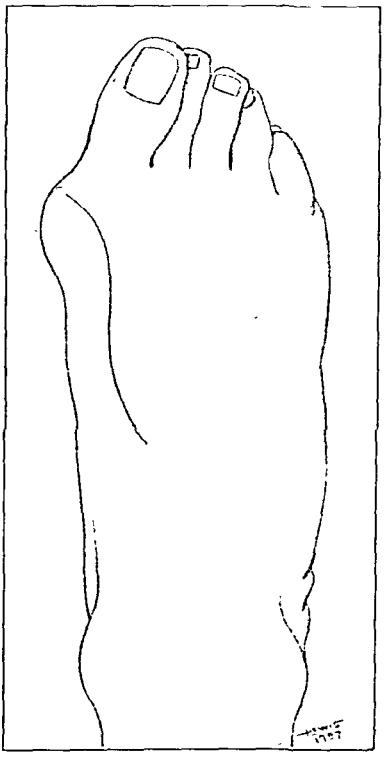


FIG. 1

## TECHNIQUE

Through an S-shaped incision dorsomedially over the level of the first metatarsophalangeal joint (Fig. 1), the bursa and the capsule covering the bony exostosis are exposed (Fig. 2). The bursa is partially dissected from above downward, exposing the dense fibrous capsule of the first metatarsophalangeal joint. Then medially through an H incision, the capsule is incised and retracted (Figs. 2 and 3), so that the bony excrescence is in the operative field (Fig. 3). This exostosis (Fig. 4), together with the medial base of the proximal phalanx (Fig. 5), is removed, and the surface is smoothed. The previously taut capsule is then redundant (Fig. 5). The lower one-half of the capsule is imbricated with the upper posterior surface of the upper flap of the capsule (Fig. 6). The extensor hallucis longus tendon, inclusive of its paratenon, is then freed from its bed (Fig. 6), and, with its insertion undisturbed, this tendon is translocated to its new bed (bursa and lower one-half of the capsule). (See Figure 7.) The dorsomedial (upper) flap is then placed over the tendon and sutured inferiorly so as to

This failure of human articular cartilage to regenerate after injury is the basis for the permanent disability which so often follows fractures into weight-bearing joints. The importance of accurate anatomical reposition of the fragments in such fractures is evident. The surgeon should also use the greatest care, when exploring joints, to avoid any injury to the surface of the hyaline cartilage. The frequent observation of areas of degeneration of the articular surfaces of the knee at operations for the removal of fractured menisci has experimental substantiation in the work of King, who observed similar degenerative changes in the articular surfaces of the knees of dogs three or four months after he had excised parts of the medial menisci. These clinical and experimental findings indicate the importance of early removal of fractured menisci. They may also explain the persistence of pain in the knee on weight-bearing often seen in industrial practice after the excision of a meniscus.

## CONCLUSIONS

1. An injury to articular cartilage which does not involve the subchondral bone is not repaired, because of the inability of fully developed hyaline cartilage to revert to a more embryonic type of connective tissue, which is the precursor of cartilage.

2. Experimental injuries which include articular cartilage and subchondral bone are repaired by the invasion of fibrous connective tissue from the underlying bone. After several months, the connective tissue resembles fibrocartilage and may show areas of metaplasia into hyaline cartilage.

3. The formation of intra-articular adhesions is favored by the complete immobilization of injured joints. Such adhesions tend to produce degenerative changes in any articular surface to which they become attached.

4. In man, articular cartilage has no power of regeneration, and the metaplasia of connective tissue into cartilage is rarely seen. Such metaplasia is more apt to result from a severe injury, with an accompanying destruction of subchondral bone, than it is to occur following injuries which involve the cartilage alone.

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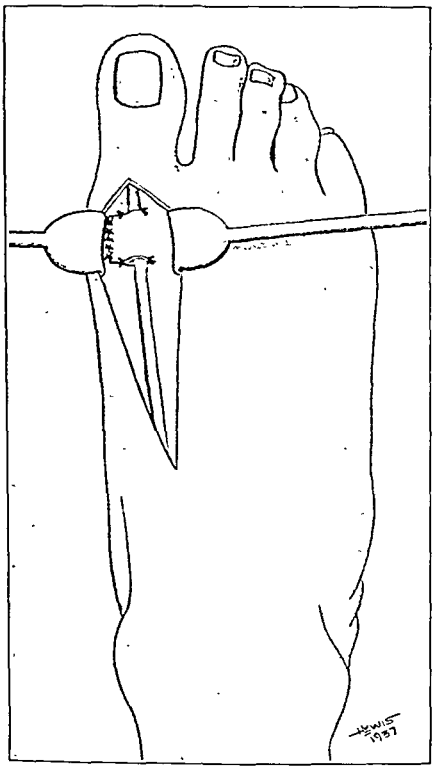


FIG. 8

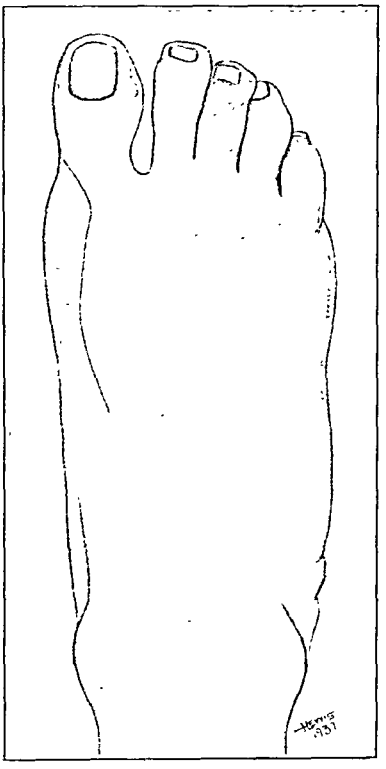


FIG. 9

This procedure has been carried out in ten cases. The end results, however, are yet to be reported. A follow-up examination in one case in which the operation was done two years ago revealed a painless metatarsophalangeal joint with full range of motion and no recurrence of the deformity.

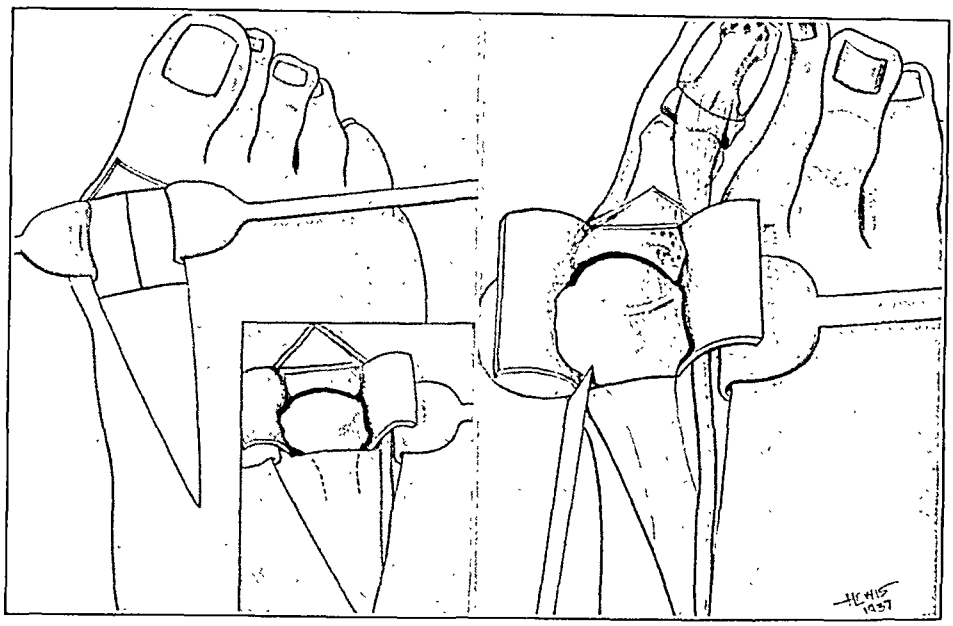


FIG. 2 FIG. 3 FIG. 4

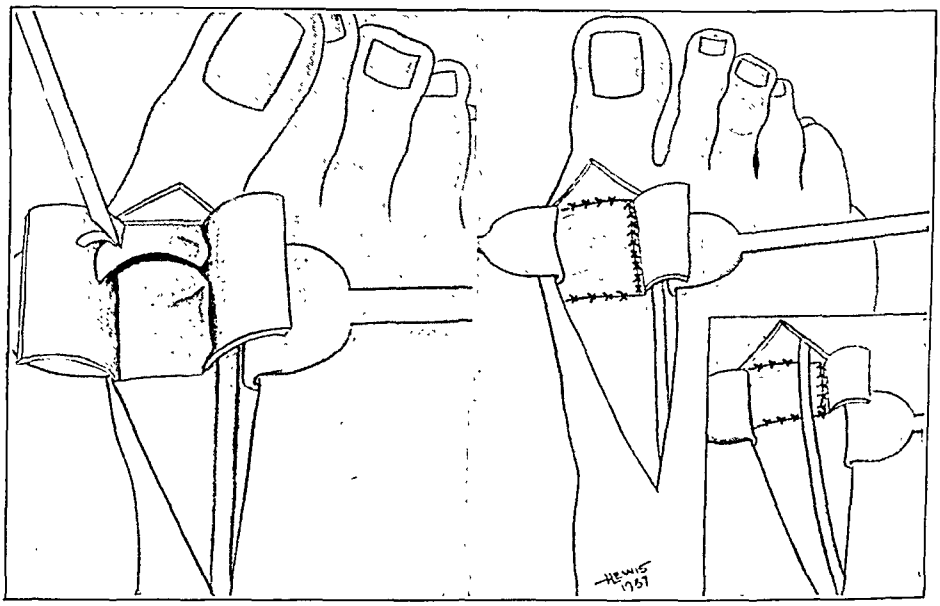


FIG. 5 FIG. 6 FIG. 7

make a canal (Fig. 8). During the entire suturing process an assistant keeps the great toe flexed, and, after the canal has been constructed, the toe is released and remains slightly adducted and flexed. The toe is easily moved from flexion to extension, since it now has a double gliding mechanism,—namely, the canal and the paratenon of the extensor hallucis longus tendon. The skin is closed and a tongue-blade splint is applied for immobilization of the joint for fourteen days.

After fourteen days the splint is removed (Fig. 9), and physiotherapy in the form of active and passive motion under water, followed by gentle massage, is instituted.

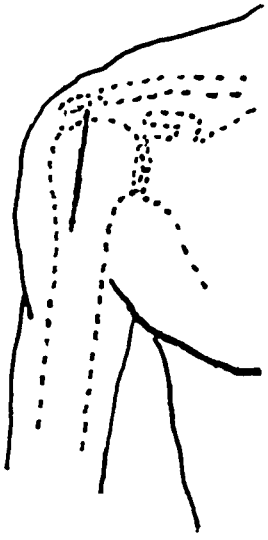


FIG. 1
The incision.

from the patient, of frequent dislocation due to slight injury or to awkward movement.

The average period of time from operation to return to work was seven weeks. It varied from one month and ten days to four months.

In Case 1 we experienced some difficulty in locating the bicipital groove. This was avoided later by placing the arm in slight abduction with the palm up. A line drawn from just within the anterior tip of the acromion to the antecubital fossa was found to follow approximately the bicipital groove. In addition, it was found easier to open the capsule of the joint and to follow the tendon down from within the joint.

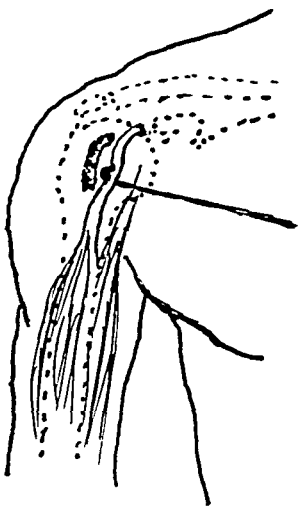


FIG. 2
The long tendon of the biceps is retracted, and the bicipital groove and the canal into the humeral head are gouged out.

In all cases we removed the synovial-membrane covering from that portion of the tendon to be fixed in the groove.

In Case 5 there was a superficial cellulitis of the wound, due to staphylococcus albus. This cleared up rapidly with drainage and dakinization and did not involve the deeper tissues.

In Case 6 the long tendon of the biceps was accidentally severed when it slipped out from under the retractor while the groove was being deepened with the gouge. Immediate suture of the tendon with black silk was performed. Follow-up of this case showed no resultant disability.

## TREATMENT

In reviewing the literature on the treatment of habitual dislocation, one is impressed with the fact that the method of plicating the capsule has been practically discarded. T. Turner Thomas' operation of plication of the capsule through the axillary approach to its inferior angle undoubtedly gave good results. Keller, in the January 1925 issue of *Annals of Surgery*, reported eleven cases in which a modification of this method was used with excellent results. The operation required three assistants,—one to hold the arm in proper position, one to make the necessary deep retraction, and one to sponge and to catch and tie bleeding points. In the largest group of cases in which good results have been reported during the past few years, the following operations have been employed: the tenosuspension method of Henderson; the biceps-tendon-

# RECURRENT ANTERIOR DISLOCATION OF THE SHOULDER

## Report of Eleven Cases Operated on by the Method of Roberts

BY BURGH S. BURNET, M.D., F.A.C.S., HOT SPRINGS NATIONAL PARK, ARKANSAS

From March 1934 to October 1937, eleven patients with recurrent anterior dislocation of the shoulder were operated on by the author on the Orthopaedic Section of the Surgical Service, Letterman General Hospital, Presidio of San Francisco, California. The operation described by Roberts, in the January 1933 issue of *The Journal of Bone and Joint Surgery*, was used, with minor modifications, in all cases. The results were so satisfactory as to warrant presentation of the cases with a view to bringing again to the medical profession the merits of this procedure.

### ANALYISS OF CASES

There were ten males and one female, varying in age from nineteen to forty-eight years. There were six recurrent dislocations of the left shoulder and five of the right. There were no patients with bilateral dislocations operated upon. The occupations of the patients were: enlisted men in the United States Army, five; commissioned officer in the United States Army, one; enrollees in the Civilian Conservation Corps, two; civilian radio announcer, one; student nurse, one; civilian employee (stevedore), one. Most of the patients were muscular young adult males of athletic habits.

The duration of habitual dislocation ranged from four months to six years.

All cases followed an acute traumatic anterior dislocation. There were no epileptics in the group.

Nine patients were followed up and reports were received from six months to three years following the operation. No recurrences were reported and in eight cases there was no disability. One of these nine patients, a stevedore, was examined six months after operation. He complained that he could not do heavy lifting on account of pain. Objectively there was practically full range of voluntary motion of the shoulder and good return of musculature. There had been no recurrence of dislocation.

The last patient of the series was operated on two months previous to the writing of this report. He has regained full motion of the shoulder and has no complaints. In one case the follow-up letter was not answered.

Five patients of the series had acute anterior dislocation of the shoulder, following minor trauma, which was reduced at this hospital. This confirmed their history of frequent dislocations. In the other six cases, diagnosis was made on the basis of the transfer diagnosis of a recently reduced dislocation in conjunction with the history, as obtained

## REPORT OF CASES

CASE 1. V. H. (No. 164543), white, male, aged forty-five years, a civilian stevedore, was admitted to the Letterman General Hospital on February 19, 1934, with a history of recurrent dislocation of the right shoulder, following a dislocation caused by a fall into the hold of a ship on October 10, 1933. The dislocation had been reduced on the same date. There had been repeated recurrent dislocations since that time, and these had been reduced at the Letterman General Hospital.

On March 1, 1934, an operation according to the method of Roberts was performed. The sutures were removed on the tenth day, and the wound healed *per primam*. Physiotherapy and active exercises were begun on the twenty-third day. The patient was discharged from the Hospital on May 18, 1934, at which time slight restriction of abduction and of external rotation and moderate weakness were present.

On September 5, 1934, examination showed voluntary abduction to 110 degrees and normal rotation of the shoulder, with full flexion and extension. The musculature was good. The patient has had no recurrence of the dislocation.

In this case, at operation, some difficulty was experienced in locating the long head of the biceps.

CASE 2. M. R. (No. 167052), white, male, aged twenty years, an enrollee in the Civilian Conservation Corps, was admitted to the Letterman General Hospital on September 5, 1934, with a history of recurrent dislocation of the left shoulder, following dislocation by a fall while carrying a bucket of water in May 1934. The dislocation had been reduced on the same date. There had been recurrent dislocations from awkward motions ever since. Roentgenographic examination of the left shoulder, on September 5, was negative.

The Roberts operation was performed on September 18, 1934. The sutures were removed on the seventh day, and the wound healed well. The patient was discharged on November 15, 1934, with a good range of motion in the left shoulder without pain. There was no recurrence of the dislocation. The patient could not raise the arm to the vertical position, but otherwise he had fully recovered. A follow-up letter sent to this patient was not answered.

CASE 3. E. J. F. (No. 168255), white, male, aged thirty years, a private in the Coast Artillery, was admitted to the Letterman General Hospital on December 10, 1934. He gave a history of recurrent dislocation of the right shoulder: the first dislocation had occurred in January 1927, while the patient was diving into a swimming pool; the second, in 1928, when he fell down a muddy slope. Following the second injury, the shoulder had been repeatedly out of place on the slightest exertion. In January 1935, at the Letterman General Hospital, while putting linen on a shelf, the patient again dislocated the shoulder. The dislocation was reduced immediately.

On January 31, 1935, the Roberts operation was performed. The sutures were removed on the eleventh day. The wound healed well, and, on the twenty-first day, active motion and physiotherapy were begun. The patient returned to duty on April 9, 1935, with a full range of voluntary motion in the right shoulder and good strength.

On November 28, 1937, the patient was again examined. He had just returned from a tour of duty in the Philippine Islands, and stated that he was able to perform full duty and to engage in athletics. He had played short stop on the baseball team, and the shoulder had given him no trouble. The dislocation had never recurred.

CASE 4. H. A. (No. 168686), white, male, aged twenty-two years, a private in the Medical Department, was admitted to the Letterman General Hospital on January 15, 1935, with a history of recurrent dislocation of the left shoulder following a dislocation when he had fallen to the wet deck of a ship while on duty in the United States Navy in 1931. There had been repeated recurrent dislocations from awkward motions since that date. The dislocation was reduced at the Letterman General Hospital on January 15, 1935. Roentgenographic examination of the left shoulder on that date was negative.

fixation operation of Nicola; and the deltoid-sling operation of Clairmont and Ehrlich.

The simplicity of the Roberts operation, as compared with other methods, appealed to the author. Its principle seemed sound,—it converted the long tendon of the biceps within the joint capsule into a suspensory ligament in a manner similar to the Nicola method, but it avoided many of the technical difficulties of that operation.

### TECHNIQUE OF THE ROBERTS OPERATION AS PERFORMED AT THE LETTERMAN GENERAL HOSPITAL

The operation is done under rigid aseptic methods. When the patient is on the operating table and the skin has been prepared, a flat sand bag is placed under the shoulder to hold it slightly raised. The arm is draped on an arm board in a few degrees of abduction and with the palm of the hand up.

With the exception of three cases in this series (Cases 8, 10, and 11) gas-oxygen-ether anaesthesia was employed.

The incision begins just below and very slightly medial to the anterior tip of the acromion and continues down through the skin and superficial fascia in the direction of the antecubital fossa for about four inches. All bleeding points are caught and tied.

The incision is then deepened by blunt separation of the upper fibers of the deltoid muscle until the capsule of the shoulder is reached. The capsule is picked up and opened with a straight incision, and the long tendon of the biceps is identified. The incision in the capsule is then carried down through the transverse humeral ligament, exposing the biceps tendon in the groove. The long tendon of the biceps is lifted out of the groove and retracted. With a gouge, the bicipital groove is deepened, all cartilage being removed from it, and this groove is then extended upward into the humeral head for about three-fourths of an inch.

The long tendon of the biceps is thoroughly roughened by rubbing it with gauze to remove its synovial covering. The tendon is then dropped back into the groove. Two or three interrupted No. 2 chromic sutures are passed through the transverse humeral ligament and through the long tendon of the biceps, anchoring it into place. The transverse humeral ligament and the opening in the capsule are then closed with interrupted plain catgut. The deltoid muscle is allowed to drop back into place, and the wound is closed and dressed.

The arm is then placed in a triangular sling tied tight enough to support the elbow. Over this is placed a muslin roller bandage about the arm and the body. This dressing holds the arm up and the shoulder in a position of adduction and internal rotation. The patient remains in bed for one week. The sutures are removed usually on the tenth day, but the sling and body bandage are not discarded before the twenty-first day, when, if the shoulder appears to be properly healed, active exercise, baking, and massage are commenced.

mobilization ought to be avoided. The type of patient, the character of the lesion, and the customary practices of the surgeon are the proper guides in these matters. It is important to note that synovectomy is not calculated to correct joint deformity except to overcome mild flexion by increasing the joint space.

Considerable question has been raised concerning the method of dealing with the menisci. This matter can be determined by the application of general principles, and, if the menisci obviously are not involved in the proliferative process and are not themselves the seat of a traumatic, inflammatory, or degenerative lesion, it is best to leave them alone. An exception to this rule may be made in cases in which their removal will greatly increase joint space and make it easier to overcome flexion.

SUMMARY

The history of synovectomy shows that this procedure has had a gradual growth over a period of fifty years and that many surgeons in different countries have contributed to its evolutionary development.

Judging from the author's personal experience and the extensive literature of the past fifteen years, the operation seems to have established for itself a field of usefulness in various kinds of joint disease.

The consensus of opinion is that synovectomy may well be employed in a joint in which extensive induration and fibrosis of the capsule, enlargement of the synovial villi, and persistent increase of joint fluid are present. Such a joint may be caused by:

1. Chronic atrophic arthritis
2. Traumatic arthritis
3. Benign tumors
4. Osteochondromatosis
5. Syphilitic arthritis
6. Intermittent hydrarthrosis
7. Synovitis ossificans
8. Hypertrophic arthritis
9. Synovial tuberculosis
10. Synovitis caused by foreign-body irritation.

Theoretical grounds appear to exist for reliance upon synovectomy as a preventive of joint deformity, but it is not intended as an operation to correct deformity.

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The Roberts operation was performed on January 22, 1935. The sutures were removed on the eleventh day, and the wound was found to have healed. On the twenty-third day, active exercise was permitted. On March 4, 1935, the patient returned to duty. He made an uneventful recovery, and strength and mobility of the shoulder steadily increased.

In December 1936, the patient was interviewed and stated that the shoulder had never again dislocated. He was able to dive, to swim, and to engage in other athletics.

CASE 5. R. J. H. (No. 171118), white, male, aged forty-eight years, an enrollee in the Civilian Conservation Corps, was admitted to the Letterman General Hospital on August 3, 1935, with a history of recurrent dislocation of the right shoulder following a dislocation sustained by falling down a flight of steps in December 1919. Since then, the shoulder had become dislocated two or three times a year. He fell against a door on August 2, 1935, and the shoulder dislocated. The dislocation was reduced at the Letterman General Hospital on August 4, 1935. Roentgenographic examination was negative.

On August 22, 1935, the Roberts operation was performed. On August 27, 1935, acute suppurative cellulitis developed in the operative wound. The wound was opened between the sutures and dakinized. Healing later took place. On September 26, 1935, the patient was discharged, with abduction of the shoulder limited to 90 degrees. Motion improved steadily. The wound had healed and the cellulitis of the operative area had entirely disappeared.

A letter from the patient, received on September 7, 1936, stated: "The shoulder has never been out of place and gives no trouble."

CASE 6. S. C. (No. 172137), white, male, aged twenty-one years, a private in the Field Artillery, was admitted to the Letterman General Hospital on November 7, 1935, with a history of recurrent dislocation of the left shoulder following a dislocation incurred about January 1930 in a wrestling bout at his home. There had been repeated recurrent dislocations since that date. On admission, slight atrophy of the left shoulder and a minor degree of weakness of the arm were noted.

The Roberts operation was performed on November 14, 1935. The sutures were removed fourteen days later, and the wound was well healed. Active motion was begun on December 4, 1935. The patient returned to duty on January 9, 1936, at which time there was a full range of voluntary motion of the left shoulder, with no pain.

On January 15, 1937, a letter from the patient stated that he had done hard labor in coal mines and that there was no stiffness of the shoulder. The joint had never again dislocated.

CASE 7. S. P. E. (No. 175153), white, male, aged thirty-nine years, weighing 215 pounds, a Major in the Field Artillery, was admitted to the Letterman General Hospital on July 5, 1936, with a history of recurrent dislocation of the left shoulder. The first dislocation of this shoulder had been sustained during a football game in 1919. The shoulder had again become dislocated during a football game in 1929; following this injury, there had been repeated recurrent dislocations. On June 1, 1936, the patient reached above his head, and the shoulder again became dislocated. The dislocation was reduced on the same day at the Letterman General Hospital.

The Roberts operation was performed on July 7, 1936. The sutures were removed on the tenth day, and the wound was well healed. The patient returned to duty on August 5, 1936, with nearly a full range of voluntary motion.

This patient was followed up for one year after operation. He engaged in strenuous physical activities; a full range of motion returned to the shoulder; and there was no further dislocation.

CASE 8. H. H. I. (No. 176090), white, male, aged twenty-two years, a private in the Infantry, was admitted to the Letterman General Hospital on September 24, 1936. He gave a history of recurrent dislocation of the left shoulder, following dislocation of this shoulder during a high-school football game in October 1931, which had been reduced on

the same day. There had been repeated recurrent dislocations since that time, — about a dozen in all. Roentgenographic examination, on September 25, 1936, was negative.

The Roberts operation was performed on September 29, 1936, under avertin reinforced by nitrous oxide-oxygen. The sutures were removed on the ninth day, and the incision was found to have healed. On the twenty-first day, the sling and bandage were removed, and active motion and physiotherapy were instituted. The patient returned to duty on November 14, 1936, at which time he had a full range of voluntary motion of the left shoulder and good strength.

On February 12, 1938, in answer to a follow-up letter, he stated: "The shoulder has never been out of place, and I can use my arm very well."

CASE 9. H. A. H. (No. 177494), white, male, aged twenty-five years, a radio announcer, was admitted to the Letterman General Hospital on October 28, 1936. He gave a history of recurrent dislocation of the right shoulder, following a dislocation incurred on October 28, 1933, in a football game, with six recurrences during the season. An operation, through an anterior incision, was performed elsewhere, but dislocation recurred two or three months later. Since that time, there had been repeated recurrent dislocations.

On October 29, 1936, the scar of the previous operation was excised, and the Roberts operation was performed. The sutures were removed on the eighth day. There was slight serous drainage from the lower angle of the wound. Five days later, the wound was well healed. On the twenty-first day, active exercise and physiotherapy were begun. The patient was discharged to his home a few days later with instructions to continue the exercise.

This patient was followed up for six months after the operation. There was no recurrence of the dislocation, and he had a full range of voluntary motion of the right shoulder. He stated that he swam and played baseball and tennis, using the right arm.

CASE 10. T. M. (No. 179615), white, female, aged nineteen years, a student nurse, was admitted to the Letterman General Hospital on June 20, 1937, with a history of recurrent dislocation of the right shoulder, following a dislocation incurred by a fall to the floor while playing basketball in September 1934. The dislocation had been reduced on the same date. One week later, she had reached above her head, and the shoulder dislocated again. There had been repeated recurrent dislocations since that time.

The Roberts operation was performed on June 22, 1937, under avertin anaesthesia. The sutures were removed on the tenth day, and the incision was found to have healed. On the twenty-first day, active exercise and physiotherapy were instituted. The patient left the hospital shortly after this.

On November 2, 1937, the patient was again seen. She had a full range of voluntary motion of the right shoulder, and there had been no further dislocation. She stated that she could use the arm freely in her duties as a student nurse.

CASE 11. F. C. (No. 180920), white, male, aged twenty-one years, a private in the Infantry, was admitted to the Letterman General Hospital on October 18, 1937. He gave a history of recurrent dislocation of the left shoulder, following a dislocation sustained in a fall on the outstretched arm during a baseball game in the summer of 1933. There had been about thirty recurrences of the dislocation during the past four years.

The Roberts operation was performed on October 21, 1937, under avertin anaesthesia. Eight days later, the sutures were removed, and the incision was found to be well healed. On the twenty-first day, all dressings were discarded, and active exercise was begun.

On November 26, 1937, a full range of voluntary motion of the left shoulder had been regained. There was good strength in the arm, and the patient had no complaint.

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# THE RESULTS OF TREATMENT OF OSTEOGENIC SARCOMA *

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Because of the current interest in the subject of osteogenic sarcoma and the lack of agreement among those who are experienced in dealing with this disease, the author has made a further study of the results of treatment at The Mayo Clinic from 1909 through 1934. Early in the study it became obvious that such tumors are rare; the incidence was about one (0.00025 per cent.) in every 4000 patients who entered The Clinic. In the period of twenty-six years covered, there were 216 cases of osteogenic sarcoma; in 187 of these, tissue was available for microscopic verification at the time of the original diagnosis, and in the remaining twenty-nine, diagnosis was based on clinical and roentgenographic findings. The average age of the patients when they presented themselves at The Clinic was 29.3 years; the youngest was three years of age and the oldest, seventy-seven years. There were 126 males (67.4 per cent.) and sixty-one females (32.6 per cent.). Trauma was a possible factor in 44.9 per cent. of the cases. The average duration of symptoms before the patients came to The Clinic was 10.4 months.

The tumors in the 187 cases were reexamined histopathologically and, whenever possible, the grade of malignancy was determined according to the method of Broders [1, 2, 3]. There was a slight increase in the percentage of so-called five-year cures in comparison with those reported in the author's previous publications: the percentages in the papers published in 1922 [5] and in 1935 [8] were 16.5 per cent. and 18 per cent., respectively, while the percentage of five-year cures in the cases in which the diagnosis was proved microscopically for the entire period is 23.4 per cent.

In a paper presented before the American Orthopaedic Association in Washington, in 1923 [6], it was stated that, although the vast majority of bone tumors (including osteogenic sarcomata) can be diagnosed from the clinical and roentgenographic findings, there is a small group of bone tumors which defy the efforts of the most expert clinical or roentgenological diagnosticians, and some of them do not reveal their identity until metastasis or death occurs. This is true to a lesser extent of those tumors which are diagnosed microscopically, but the percentage of correct findings is higher than when reliance must be placed on clinical or roentgenographic means only.

The writer was not surprised when a distinguished surgeon, who was participating in a symposium on malignancy of bone, asked an eminent pathologist what he meant by the adjective "osteogenic". The reply was

* Read at the Annual Meeting of the American Orthopaedic Association, Atlantic City, New Jersey, May 3, 1938.

that the word meant "arising from bone-producing cells". Thus, an osteogenic sarcoma is a malignant tumor which develops from tissue that is predestined to form bone, and the term "osteogenic sarcoma" denotes many of the growths previously designated by terms such as "osteosarcoma", "chondrosarcoma", "osteochondrofibrosarcoma", "osteochondrofibromyxosarcoma", etc.; among these terms, also, should be mentioned "periosteal osteogenic sarcoma". When one of the foregoing mixed terms is used, the intention, as a rule, is to denote the type of tissue which is predominant in the tumor. The anatomical terms "periosteal" and "central" have been generally discarded in relation to sarcoma, as have also the roentgenological terms "sclerosing" and "osteolytic", except when they are used in a more or less colloquial sense. However, the terms "periosteal fibrosarcoma" and "periosteal osteogenic sarcoma" are still employed to denote tumors which continue to be recognized. Periosteal fibrosarcomata [9] (Fig. 1) probably arise from the outer portion of the periosteum or neighboring tissue; they may cause absorption of bone or, later, invasion and these processes may give rise to the supposition that the growth is a primary bone tumor. Periosteal osteogenic sarcoma (Fig. 2) apparently arises from the corticoperiosteal tissue and produces true bone, or osteo-



FIG. 1

Periosteal fibrosarcoma of upper part of arm. Involvement of shaft of humerus is secondary and the tumor is not producing any bone.



FIG. 2

Periosteal osteogenic sarcoma producing bone, the roentgenographic appearance of which resembles a sunburst. This tumor involved the central and cortical bone as well as the soft tissue.

genic sarcoma. Broders and Pemberton [4] have reported finding an osteogenic sarcoma in the thyroid gland, but growths in such unusual situations are not of concern in this study.

Moreover, it is not the author's purpose to present a review of the results of investigations reported by other physicians. A correct diagnosis is the prime requisite in the scientific evaluation of results of treatment of osteogenic sarcoma, as the subsequent history not infrequently proves the first opinion to have been incorrect. Thus, in this series of 187 cases, the tissue has been reexamined microscopically by expert pathologists in an attempt to group the tumors as to the degree of malignancy. On the basis of this reexamination, the original diagnoses have been revised when necessary.

In all of these cases, roentgenograms of the lungs were made to exclude the presence of visible metastasis. The method of treatment employed was not always the method of choice, because patients and relatives failed to follow the advice given by their surgeons and preferred to have the less mutilating procedures carried out. Should immediate amputation be urged, the patient is likely to flee to a physician who is believed to be more conservative. This may result in loss of precious time and only after failure of conservative methods does the patient consent to radical surgical treatment. Thus the delay in amputation in Case 1 might be condemned, but the original recommendation by the surgeon was rejected, and three years passed before the patient consented to amputation.

The follow-up record of today is more efficient than it was in the past, but one is still confused when confronted by the various types and combinations of treatment employed in various parts of the country. The patients go from one physician to another, and treatment is seldom carried out in one place; this results in a variety of diagnoses and advice. Were it possible to see immediately every patient who has a painful condition of bone, and if clinical and roentgenographic examinations could be made by expert physicians, an early diagnosis could be made and a more favorable prognosis given.

Surgical treatment is more or less limited, and in some cases it is impossible to obtain more than a section of tissue for diagnosis. The situation and size of the tumor and the previous treatment must be taken into consideration. A glance at Figure 3, which discloses the situation of the malignant osteogenic tumors, is convincing. The skill and judgment of the surgeon in selecting and carrying out the method of treatment best suited to the individual patient are other important factors in the results. The argument for amputation is at times more attractive than another operation which might result in the necessity of prolonged care, in recurrence, in ulceration, and possibly in a charge of negligence if further consultation should demonstrate metastasis. Moreover, many patients live long distances from adequate and skillful radiologists and cannot afford, or will not take the time, to go to institutions for frequent reexamination. In a few instances also, the danger of sterility, because of the situation of

the tumor, causes the patient to refuse irradiation. Rarely is a physician in general practice willing alone to pass judgment, to assume responsibility for the diagnosis, and to carry out treatment in cases of bone sarcoma. Early accurate diagnosis, institution of the selected method of treatment, and evaluation of the result of treatment reach their maximal worth when the cooperation of specialists is available. Thus, the great medical centers and the Registry of Bone Sarcoma of the American College of Surgeons offer the physician the facilities of experts in this field.

### RADIUM OR ROENTGEN THERAPY

Before 1920, systematic radiotherapy for tumors of this kind was, to all intents, not used at The Mayo Clinic. Since 1920, increasing use of radium or roentgen rays has been made in selected cases. More and more the tendency has been to use multiple converging beams, the quality of the rays varying according to the mass of tissue in which the tumor is situated. Preoperative irradiation, as now understood, has not been tried. By force of circumstances, treatment has been almost entirely postoperative, some patients receiving all their treatment at The Clinic, while others have received part of their treatment at The Clinic and part at home.

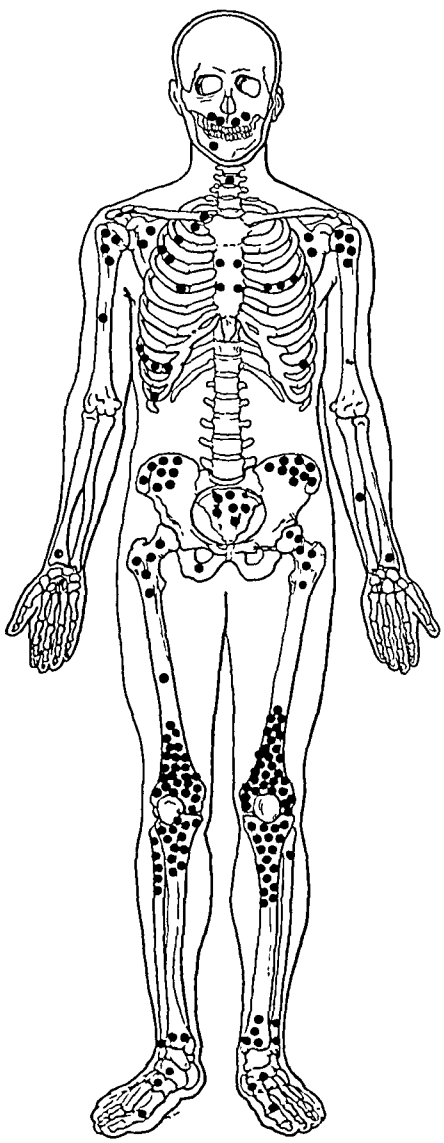


FIG. 3

Situation of 187 osteogenic sarcomata. (See Table I.)

The writer believes that no one but a radiologist who has had special experience in the treatment of these tumors should undertake to use radium or roentgen rays in these cases. By placing treatment in such hands, the danger of untoward results is diminished.

The twenty-nine patients concerning whom diagnosis was made from clinical and roentgenographic findings received irradiation therapy or irradiation therapy and Coley's toxins. Of these, the author was able to trace twenty-seven and of this latter number only two (7.4 per cent.) lived more than three years and none survived five years. Approximately two-thirds of these patients died of metastases in less than one year. Since these patients could not be grouped as to the degree of malignancy, and some doubt may exist as to the accuracy of the diagnosis of osteogenic sarcoma, they

TABLE I

SITUATION OF 187 OSTEOGENIC SARCOMATA *

| Situation | Right | | | Left | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Upper | Middle | Lower | Upper | Middle | Lower | No. | Per Cent. |
| Femur | 5 | 1 | 24 | 6 | 0 | 30 | 66 | 35.3 |
| Tibia | 12 | 0 | 2 | 17 | 0 | 4 | 35 | 18.7 |
| Humerus | 4 | 1 | 0 | 5 | 0 | 0 | 10 | 5.3 |
| Fibula | 5 | 0 | 1 | 1 | 0 | 2 | 9 | 4.8 |
| Radius | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 1.1 |
| Ulna | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0.5 |
| Ilium | | | | | | | 17 | 9 2 |
| Ribs | | | | | | | 15 | 8.1 |
| Feet | | | | | | | 6 | 3.3 |
| Sacrum | | | | | | | 6 | 3 3 |
| Jaw | | | | | | | 5 | 2.6 |
| Scapula | | | | | | | 4 | 2.1 |
| Spine | | | | | | | 4 | 2.1 |
| Sternum | | | | | | | 4 | 2 1 |
| Hyoid bone | | | | | | | 1 | 0 5 |
| Clavicle | | | | | | | 1 | 0.5 |
| Ischium | | | | | | | 1 | 0 5 |
| Total | | | | | | | 187 | 100 0 |

* Note the percentage of tumors in the region of the knee, the humerus, and the pelvis.

will not be included in any of the additional statistics given in this paper.

As has been said, when these twenty-nine patients were excluded, 187 remained from whom tissue was available for microscopic examination at the time of the original diagnosis. Of these 187 patients, 184 were traced. Of the 184 traced patients, some received Coley's toxins and 40 per cent. of those who did receive this treatment survived three years. Of those patients who did not receive Coley's toxins, 34 per cent. survived three years. The five-year survival rate among those patients who received Coley's toxins was 26 per cent., whereas that of the patients who did not receive this treatment was 23 per cent. Although there is a slight advantage in survival in favor of the patients who received Coley's toxins, it is difficult to evaluate its significance. In the first place, only twenty-five patients received this treatment. Also, the treatment was carried out

TABLE II

CASES OF OSTEOGENIC SARCOMA IN WHICH HISTOLOGICAL SPECIMENS WERE AVAILABLE, GROUPED BY HISTOLOGICAL GRADE (BRODERS' METHOD)—SURVIVAL AFTER TREATMENT

| Group | Lived Three or More Years after Treatment | | | | Lived Five or More Years after Treatment | | | |
|---|---|---|---|---|---|---|---|---|
| | Patients Treated* | Patients Traced | Patients | Percentage of Traced Patients | Patients Treated* | Patients Traced | Patients | Percentage of Traced Patients |
| Grade 1 | 17 | 17 | 11 | 64.7 | 12 | 10 | 6 | 60.0 |
| Grade 2 | 39 | 39 | 13 | 33.3 | 33 | 33 | 5 | 15.1 |
| Grade 3 | 39 | 39 | 8 | 20.5 | 36 | 36 | 6 | 16.7 |
| Grade 4 | 25 | 24 | 4 | 16.7 | 19 | 18 | 2 | 11.1 |
| Not graded | 67 | 65 | 28 | 43.1 | 66 | 61 | 18 | 29.5 |
| Total | 187 | 184 | 64 | 34.8 | 166 | 158 | 37 | 23.4 |

* Inquiry as of January 1, 1938. The three-year group comprises the patients treated three or more years prior to the time of inquiry,—that is, 1934 or earlier. The five-year group comprises those treated in 1932 or earlier,—that is, the five-year treated group is included in the three-year table. The column "Patients Traced" in the three-year table includes those treated patients who have been traced for three years or more; the same column in the five-year table represents the treated patients who have been traced five years or more. A patient treated five years or more prior to the time of investigation and known to be alive three years after treatment, but lost track of after that time, will be included in the treated group of both tables, but in the traced group of only the three-year table, since such a patient has been traced for three years after treatment, but not for five years.

by home physicians and the author was dependent on their reports as to the administration of the toxins. Moreover, the treatment as respects irradiation and surgical measures was not uniform in this group.

The writer had no experience with treatment by means of lead in this series of 187 cases of osteogenic sarcoma.

As the author expressed the opinion in 1934 [8] that one of the most important ways of classifying osteogenic sarcoma was by grading the degree of malignancy, it was gratifying to confirm the fact that expectancy of life and result of treatment were actually influenced by the grade of malignancy as determined by the pathologists. Of the 187 cases in which tissue was available for microscopic verification at the time of the original diagnosis, in 120, or 64 per cent., the malignancy of the tumors was graded. The five-year survival rates are given in Table II. To be sure, the high rate of survival of patients whose tumors were of Grade-1 malignancy is based on a comparatively small number of cases. However, this large survival rate in the presence of malignancy of low grade agrees well with all studies made at The Clinic in regard to the significance, with respect to survival, of grading of the degree of malignancy of other tissues. It is justifiable to feel confident of the soundness of the general conclusion that, in the presence of tumors of low-grade malignancy, prognosis for five-year survival is considerably better than it is in the

presence of tumors of higher grades of malignancy, even if the more conservative surgical measures are employed in the treatment of the tumors of lower grade.

### BIOPSY

In four cases biopsy alone was performed. (See Table III.) In two of these, the tumor was in the bony pelvis and the patients died seven and eighteen months after the specimen was taken. One patient had a tumor of the ribs and died one month after biopsy; in the remaining case, the tumor was in the upper part of the humerus, and the patient died five months after excision of the specimen.

Biopsy is of value if there is any question as to benignancy or malignancy of a lesion of bone; it is of value, also, in making possible the grading of a malignant lesion. The experience of the pathologist is directly related to the value of biopsy. The surgeon must be certain that the material he submits to the pathologist is true tumor tissue and, if the histopathological diagnosis is not in agreement with his clinical opinion, more tissue should be examined. As a rule, the author prefers the open operation in performing a biopsy, for it permits inspection of the tumor and allows sufficient tissue to be obtained from a typical portion of the

TABLE III

CASES OF OSTEOGENIC SARCOMA IN WHICH HISTOLOGICAL SPECIMENS WERE AVAILABLE, GROUPED ACCORDING TO TREATMENT—SURVIVAL AFTER TREATMENT

| Group | Lived Three or More Years after Treatment | | | | Lived Five or More Years after Treatment | | | |
|---|---|---|---|---|---|---|---|---|
| | Patients Treated* | Patients Traced | Patients | Percentage of Traced Patients | Patients Treated* | Patients Traced | Patients | Percentage of Traced Patients |
| Biopsy only | 4 | 4 | 0 | | 4 | 4 | 0 | |
| Irradiation only | 38 | 37 | 6 | 16 2 | 35 | 33 | 3 | 9 1 |
| Excision ** | 56 | 55 | 28 | 50.9 | 49 | 44 | 15 | 34 1 |
| Amputation ** | 89 | 88 | 30 | 34 1 | 78 | 77 | 19 | 24 7 |
| Total | 187 | 184 | 64 | 34 8 | 166 | 158 | 37† | 23 4 |

* Inquiry as of January 1, 1938. The three-year group comprises the patients treated three or more years prior to the time of inquiry,—that is, 1934 or earlier. The five-year group comprises those treated in 1932 or earlier,—that is, the five-year treated group is included in the three-year table. The column "Patients Traced" in the three-year table includes those treated patients who have been traced for three years or more; the same column in the five-year table represents the treated patients who have been traced five years or more. A patient treated five years or more prior to the time of investigation and known to be alive three years after treatment, but lost track of after that time, will be included in the treated group of both tables, but in the traced group of only the three-year table, since such a patient has been traced for three years after treatment, but not for five years.

** With or without irradiation.

† Of the thirty-seven patients who lived five years or more, five, or 13.5 per cent., had received Coley's toxins.

TABLE IV

OPERATIONS BY GRADE OF MALIGNANCY

| | Total | Biopsy | | Excision | | Amputation | |
|---|---|---|---|---|---|---|---|
| | | *No.* | *Per Cent.* | *No.* | *Per Cent.* | *No.* | *Per Cent.* |
| Grade 1 | 17 | 2 | 11.8 | 15 | 88.2 | 0 | 0.0 |
| Grade 2 | 39 | 13 | 33.3 | 9 | 23.1 | 17 | 43.6 |
| Grade 3 | 39 | 9 | 23.1 | 5 | 12.8 | 25 | 64.1 |
| Grade 4 | 25 | 6 | 24.0 | 5 | 20.0 | 14 | 56.0 |
| Not graded | 67 | 12 | 17.9 | 22 | 32.8 | 33 | 49.3 |
| Total | 187 | 42* | 22.5 | 56† | 29.9 | 89 | 47.6 |

* Thirty-three patients also received irradiation; five received irradiation plus Coley's toxins.

† Forty-four patients also received irradiation; two received irradiation plus Coley's toxins.

tumor. The tourniquet is employed whenever possible, and every care is taken to minimize trauma to tissue. Taking of material for biopsy by means of a needle is useful if tumors are vascular and difficult of approach; some osteogenic sarcomata make such a procedure difficult. The writer has found biopsy and the cooperation of a skilled pathologist of inestimable value in clearing up the question of diagnosis in that group of cases wherein there is some doubt as to the true nature of the lesion. Furthermore, grading of the degree of malignancy may alter the decision as to the type of treatment and prognosis.

### IRRADIATION FOLLOWING BIOPSY

The percentage of five-year cures among traced patients who were treated by irradiation following biopsy was 9.1. All such treatment was not carried out at The Clinic, for it was necessary to cooperate with roentgenologists near the homes of some of the patients. Irradiation was employed because it was selected by the patient in preference to surgical treatment or because the size or situation of the tumor made its removal impossible. Regression of the growth and temporary improvement were noted in some cases; atrophy of bone and soft tissue and stiffness of joints occurred in others. With further knowledge and development of irradiation, improved results may make it the method of choice, but the author's experience to date has indicated that osteogenic sarcoma is inadequately responsive to this form of treatment. (See Table III.)

### EXCISION

Excision of osteogenic sarcoma was performed in a large number of cases when the degree of malignancy was low, when the tumors were of

such size and were so situated as to make amputation impossible, or when the patient refused to have more radical procedures carried out. When excision is performed in the early stages of the disease and the degree of malignancy is low, expectancy of life is increased and a functioning extremity may be preserved. When recurrence takes place, however, in spite of postoperative irradiation and treatment with Coley's toxins, late amputation may be contra-indicated because of metastasis. Complete excision of bone, followed by adequate irradiation, may result in extensive scarring; then reconstructive surgical treatment, such as bone grafting, may result in formation of an ulcer, loss of the graft. and, finally, amputation. Of the 187 patients herein considered, twenty-seven, or 14.4 per cent., came to The Clinic following previous excision; fifty-three, or 28.3 per cent., had some form of surgical treatment, irradiation, treatment by means of Coley's toxins, or a combination of these. Of forty-four patients treated by excision, with or without irradiation or administration of Coley's toxins, and traced for five years, fifteen (34.1 per cent.) lived five years or more. (See Table III.)

### AMPUTATION

Consent to amputation is given by the patient or responsible relatives only when the more conservative measures have failed or the condition has become unbearable as a result of pain, disfigurement, or disability. Thus, amputation is often of a palliative nature, permitting the patient a period of relief from symptoms, during which time there is a temporary gain in weight and improvement of morale. Postoperative irradiation, as well as administration of Coley's toxins, is employed in the hope of destroying unrecognized metastatic growths. Although a considerable fraction of the writer's patients who came to amputation had undergone previous conservative surgical treatment, or combinations of surgical treatment with irradiation and administration of Coley's toxins, instead of early amputation, the five-year survival rate after treatment at The Clinic was 24.7 per cent. (See Table III.)

The site of amputation should be well away from the tumor. Patients frequently insist on saving length of limb and thus risk the possibility of early local recurrence. The author prefers amputation above the knee if a tumor is about the ankle, and through the upper part of the femur if the tumor is about the knee, saving enough of the extremity, when possible, for use of a prosthetic apparatus. If a tumor is in the region of the elbow, high humeral amputation or disarticulation at the shoulder usually is employed.

### CHOICE OF OPERATION

In the foregoing paragraphs much has been written about the choice of operation. The operations employed in the 187 cases, in relation to the grade of malignancy of the tumors, are recorded in Table IV. If the malignancy was of Grade 1, amputation was never employed. There was no operative mortality in this series of 187 cases.

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under the supervision of her local physician, after which she refused to continue with this form of treatment.

A member of the American Orthopaedic Association, who examined this patient eighteen months following treatment, wrote: "This looks like a cure of sarcoma by x-ray . . . lengthening of the tendo achillis was performed." The patient stated at this time that she was in perfect health and believed that she was cured. Three years and a half after she had been advised to undergo amputation at The Clinic, this was performed elsewhere and the woman died three months later. At necropsy, the diagnosis of metastasis to the lungs was confirmed.

In order to save space in the following reports of cases, the writer has not given treatment by irradiation in detail.

CASE 2. A man, aged twenty-one years, injured the right ilium thirteen months previous to his admission. Two months later, pain developed in the knee and stiffness in the hip. A diagnosis of osteogenic sarcoma of the right ilium was made by the clinician and the roentgenologist. (See Figure 5.) Roentgenograms of the thorax were negative for metastasis. The patient received twelve local treatments by irradiation and died six months later.

CASE 3. A boy, aged sixteen years, had had pain in the right shoulder, without trauma, of six months' duration. Examination disclosed a tumor of bone. Roentgenograms of the thorax were negative for metastasis. Clinical and roentgenographic diagnoses of osteogenic sarcoma of the upper part of the right humerus were made. (See Figure 6.) Amputation was refused and treatment by irradiation was given. The patient died of pulmonary metastasis seven months later.

CASE 4. A man, aged twenty years, complained of loss of weight of fifteen pounds (seven kilograms) and of pain and swelling of the right ilium. He did not give a history of trauma. A diagnosis of tuberculosis was made elsewhere and, on aspiration, "blood and white material" were obtained. The roentgenologists at The Clinic found roughen-

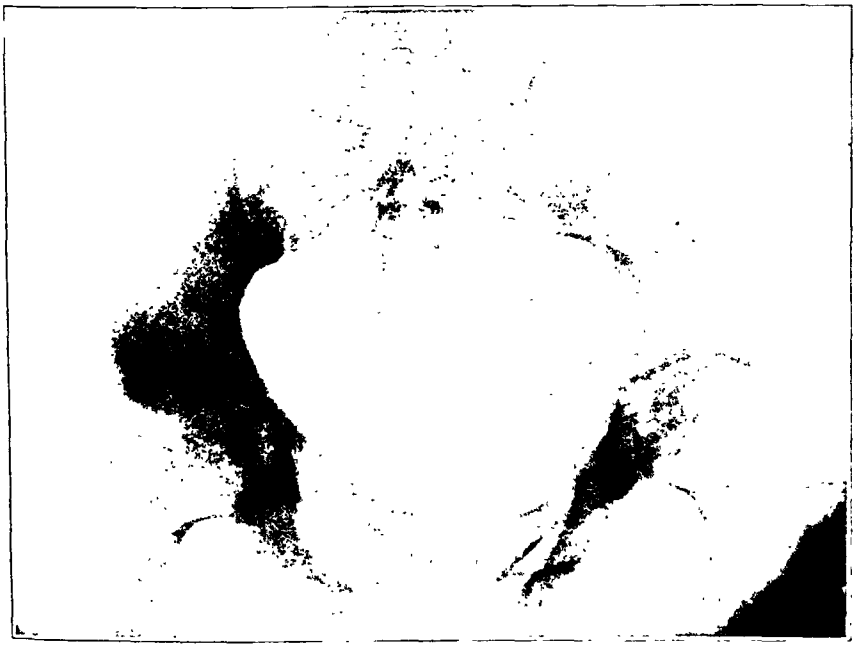


FIG. 5

Case 2. Osteogenic sarcoma of the right ilium involving the hip joint.

The following cases illustrate some of the points made in this paper. Some patients refused amputation when it possibly would have given a favorable result. In other cases the tumor was in an inaccessible location, and the only possible treatment was irradiation.

## REPORT OF CASES

CASE 1. A woman, aged thirty years, was admitted to The Clinic with the complaint of pain, stiffness, and swelling about the left knee of two months' duration. She had lost forty pounds (eighteen kilograms) in the past two years.

Her height was five feet, six inches (168 centimeters) and her weight 117 pounds (fifty-three kilograms). Her blood pressure was slightly elevated and her temperature was normal. A firm, immovable, smooth mass, which was somewhat tender, was palpable on the medial and anterior aspects of the left knee. There was no local increase in warmth, and no redness or enlargement of veins, but there was limitation of flexion of the knee. General examination, including urinalysis, blood count, and flocculation test, gave negative results. Roentgenograms of the thorax were negative. The roentgenologists were of the opinion that the tumor was an osteochondroma. (See Figure 4.)

A clinical diagnosis of sclerosing osteogenic sarcoma of the lower part of the left femur was made. Biopsy with a tourniquet in place and, providing the tissue proved malignant, amputation were advised. The patient refused biopsy and amputation and was referred for roentgenotherapy, courses of which were given from time to time.

The first course, which was given in May 1931, consisted of irradiation over six fields; there were two rows of three fields each, the dividing line between the upper and lower rows corresponding to the center of the tumor. Each field was irradiated as follows: voltage, 135 peak kilovolts; filtration, six-millimeter aluminum; focal-skin distance, forty centimeters; milliamperes, five; time, twenty-eight minutes; dose, 560 roentgen units (total dose, 3360 roentgen units). The second course of treatment was given in June 1931, over six fields; the conditions of irradiation were the same as for the first course. The third course was given in July 1931; the conditions of irradiation were the same as for the first and second courses, except that each field received 520 roentgen units (total dose, 3120 roentgen units). The fourth course was given in August 1931, and was similar in every respect to the third course. The fifth course was given in September 1931, over six fields, each receiving 500 roentgen units (total, 3000 roentgen units). The sixth course was given in October 1931, and was exactly the same as the fifth course.

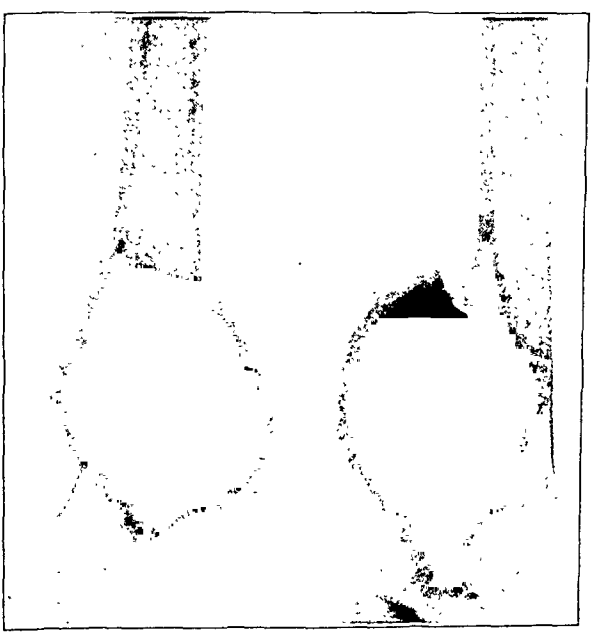


FIG. 4

Case 1. Osteogenic sarcoma of the lower part of the left femur.

Subsequent to these courses of treatment, the patient still refused to have amputation performed and, as examination of the thorax was negative, the patient was finally dismissed in December 1931, at which time her condition was definitely improved and she had gained weight.

In January 1932, she received eleven injections of Coley's toxins

ensuing months. The patient's death two years after biopsy was ascribed to toxaemia resulting from malignancy.

CASE 6. A married woman, aged forty-one years, had submitted to excision of a tumor of the third thoracic vertebra, and subsequent irradiation, three times in seven years. On admission to The Clinic, she complained of pain and swelling. Roentgenograms of the thorax were negative for metastasis. A fourth excision was performed and irradiation given in 1927. In 1934 she returned with a recurrence, and the fifth excision was performed, followed by irradiation. In 1937 she underwent excision a sixth time and she was last heard from in October 1937, ten years and five months following her first operation at The Clinic, or about seventeen years and six months following onset of symptoms. The pathologist, on reviewing the tissue, classified the tumor as an osteogenic sarcoma (Grade 1).

CASE 7. A girl, aged eleven years, after having been treated for sciatic pain for six months, was brought to The Clinic because of pain and swelling in the upper part of the left femur. A clinical diagnosis of sarcoma and a roentgenographic diagnosis of osteochondroma were made. (See Figure 7.) Roentgenograms of the thorax were negative for metastasis. Excision was performed and the pathologist reported osteogenic sarcoma (Grade 3). Radium therapy (14,000 milligram hours) was given. The patient wrote on April 1, 1938, that she was in good health; this was seven years following excision.

CASE 8. A man, aged twenty-one years, complained of pain in the left shoulder; this had immediately followed an injury sustained six months previous to admission. Roentgenograms of the thorax were negative. The clinical and roentgenographic diagnoses of osteogenic sarcoma were substantiated by microscopic examination, which disclosed that the malignancy was of Grade 2. The patient refused treatment and returned home. Five months later, an inquiry revealed that he had died.

CASE 9. A girl, aged fifteen years, complained of pain and swelling of eight months' duration, in the lower part of the left tibia. She did not give a history of trauma. A diagnosis of osteomyelitis had been made. The roentgenograms of the thorax were negative for metastasis. A diagnosis of sarcoma was made and amputation was performed through the upper part of the tibia (Fig. 8); following this she received treatments by irradiation. She was living and well April 1, 1938, sixteen years and three months following treatment.

CASE 10. A boy, aged sixteen years, complained of persistent pain and swelling in the upper part of the left tibia following an injury sustained nine months previous to his admission. Roentgenograms of the thorax were negative. A diagnosis of sarcoma was made (Fig. 9) and amputation through the middle of the thigh was

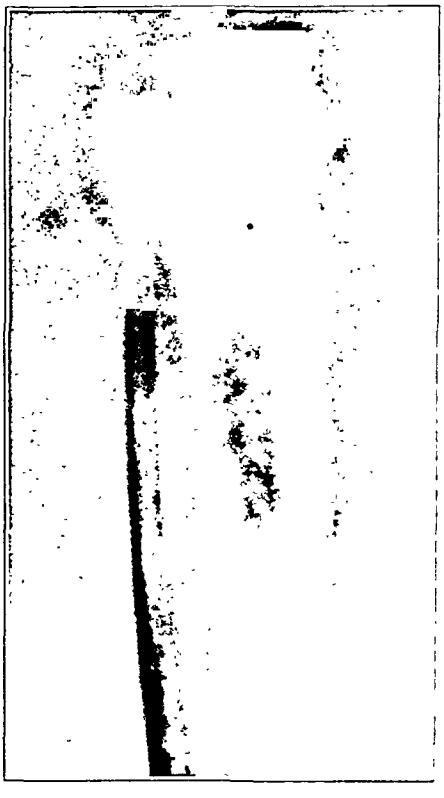


FIG. 9

Case 10. Periosteal osteogenic sarcoma of the upper part of the left tibia.



FIG. 6

Case 3. Osteogenic sarcoma of the upper part of the right humerus.

ing and erosion of the ilium, suggestive of sarcoma, but no evidence of pulmonary metastasis. Biopsy resulted in a diagnosis of osteogenic sarcoma. Pulmonary metastasis occurred eleven months following the onset of symptoms. Five months following biopsy the patient died.

CASE 5. A man, aged fifty-three years, had been given a diagnosis of tuberculosis of the seventh cervical vertebra and had received treatment for this and for neuritis. On examination, one year following the onset of symptoms, the roentgenologist considered the possibility of the presence of Pott's disease and found the thorax negative for metastasis. The clinician felt that malignancy was more likely to be the underlying condition, and biopsy proved that an osteogenic sarcoma (Grade 4) was present and was causing radiculitis from compression. Twelve treatments with high-voltage roentgen rays were given during the



FIG. 7

Case 7. Osteogenic sarcoma of the upper part of the left femur.

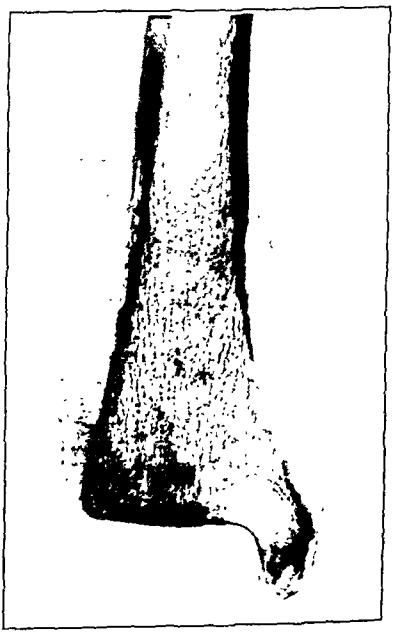


FIG. 8

Case 9. Roentgenogram of gross specimen giving evidence of osteogenic sarcoma of the left lower tibia.



FIG. 11

Case 12. Postoperative osteogenic sarcoma with pathological fracture of the upper part of the right humerus.

## SUMMARY

Knowledge as to the therapeutic value of the methods of treatment in cases of osteogenic sarcoma depends on accurate records and follow-up reports of clinician, roentgenologist, surgeon, and pathologist. The incidence of this rare malignant tumor was one in 4000 patients who presented themselves at The Mayo Clinic for treatment.

The relation of the grade of malignancy of osteogenic sarcomata to the survival of the patients was similar to that which exists in the presence of malignancy of other neoplasms of other tissues.

Patients whose tumors were of a low grade of malignancy had the highest record for five-year survival. Grade 1 was associated with a five-year survival rate of 60 per cent.; Grades 2 and 3, with an average five-year survival rate of 15.9 per cent.; and Grade 4, with a five-year survival rate of 11.1 per cent.

Of those patients treated by irradiation only, and traced for five years, 9.1 per cent. lived five years or more; of those treated by excision, with or without irradiation, 34.1 per cent. lived five years or more; and of those



FIG. 10

Case 11. Postoperative osteogenic sarcoma of the left ulna.

performed. Fourteen months later, and just previous to the patient's death, roentgenographic examination disclosed pulmonary and pelvic metastases. He had not received other treatment.

CASE 11. A girl, aged seventeen years, gave a history of having injured the left ulna one year previous to admission. Following the injury, symptoms developed and the attending surgeon diagnosed osteomyelitis; he then operated for this condition. Examination revealed a large tumor of the forearm, with local pain, swelling, and warmth. A diagnosis of sarcoma was made by the clinician and the roentgenologist. (See Figure 10.) Roentgenograms of the thorax were negative for metastasis. Certain factors made it advisable for us to have microscopic proof of the diagnosis and, on examination of tissue removed, the pathologist reported osteogenic sarcoma (Grade 4). Irradiation treatment was chosen by the patient, and ten courses of low-voltage roentgenotherapy were given. Six months later an attempt was made to carry out a conservative operation. The patient died of pulmonary metastasis twenty-eight months from the onset of symptoms.

Early diagnosis resulting from roentgenographic examination and microscopic grading of the degree of malignancy, together with prompt amputation, might improve the expectancy of life in such a case.

CASE 12. A married woman, aged fifty-six years, had injured the right humerus two and a half years previous to admission; five months later, slight pain and swelling had developed in this region. Local excision had been performed and fifteen treatments with Coley's toxins had been given elsewhere, fourteen months previous to her arrival at The Clinic. At The Clinic a diagnosis of huge recurring sarcoma of the humerus, with pathological fracture, was made. (See Figure 11.) Roentgenograms of the thorax were negative for metastasis. An intrascapular thoracic amputation was performed and the pathologist reported the presence of osteogenic sarcoma. The patient took Coley's toxins under direction of her physician at home. In a report received April 1, 1938, twenty-one years following amputation, she stated that she was in good health.

# ROENTGENOTHERAPY IN ACUTE OSTEOPOROSIS

## A New Type of Treatment *

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Osteoporosis is that condition of bone in which there has occurred a demineralization or an absorption of the mineral salts of the bone, and it is manifested by a thinning of the bone shadow in the roentgenogram.

Osteoporosis is usually characterized as acute or chronic. Perhaps a better classification would be based upon the presence or absence of symptoms. It is only too often impossible to determine the time of the onset of the demineralization, and the change is discovered only when the parts are x-rayed for some other condition with which the osteoporosis is associated.

The symptom-free type of osteoporosis is found in disuse, endocrine disturbances, chemical poisoning, infection, nutritional diseases, and lesions of the central nervous system and of the circulatory system. The bone salts reappear as a rule when the associated condition has been removed. In this type, the roentgenographic study shows a diffuse uniform general thinning of the bone. In the extreme type, especially in those cases involving large areas such as the spine and the pelvis, the cortex is a thin, penciled white line, and the medullary portion of the bone is represented by a faint outline of the longitudinal trabeculae. Stereoscopically the bone looks like a box made of parchment and filled with cobwebs. Tuberculosis of the hip joint is associated with an atrophy which is characterized by a very marked thinning of the cortex. (See Figure 2.) This symptom-free type of osteoporosis is not a subject of discussion at this time.

The type of osteoporosis with symptoms is usually called "acute bone atrophy" or "Sudeck bone atrophy". It is this type alone which will be discussed.

The history of acute osteoporosis is usually that of a trivial injury, such as a bruise or a sprain, to the foot or the hand and wrist, although it may be found in association with more severe lesions, especially Colles' fractures and fractures of the calcaneum. It is rather characteristic that those parts composed of small bones (red marrow) and multiple joints are most frequently involved.

Following the injury or trauma to the part, there may not at first be any external evidence of a serious change in the bone,—the skin is normal in color and the function of the parts is undisturbed by pain. Within a comparatively short time, the patient complains of a severe throbbing ache, which is constant and which is *not relieved by heat or by rest*. The skin

* Read at the Annual Meeting of the American Orthopaedic Association, Atlantic City, New Jersey, May 3, 1938.

treated by amputation, with or without irradiation, 24.7 per cent. lived five years or more.

Excision was employed in a relatively favorable group of cases. Amputation sometimes was used with the understanding that it was only a palliative measure; it was not used at all if the malignancy was of Grade 1.

Of 158 patients treated by any method, and traced for five years, 23.4 per cent. lived five years or more after treatment.

## CONCLUSIONS

When every painful bony structure is subjected to thorough roentgenographic examination, bone tumors will be diagnosed earlier. When these early cases come into the hands of those experienced in diagnosis, in grading the degree of malignancy, and in unbiased choice of treatment, more limbs will be saved and more lives prolonged.

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# THE EVOLUTION OF THE KNEE JOINT *

BY MAURICE H. HERZMARK, M.D., NEW YORK, N. Y.

The knee joint is the largest joint in the body and the most vulnerable one. It is more complex than most joints. The semilunar cartilages, the cruciate ligaments, the large synovial membrane, and the overlying patella are all structures designed for protection and stability, and yet each of these is a frequent source of knee pathology.

In order to learn more of the function of these various structures found in the human knee joint and to discover, if possible, their origin, the knees of a series of animals were dissected and studied. Animals were selected according to their phylogenetic development in the main line of ascent from amphibians to primates.

Before describing the details of the knee joints of these animals, it would seem helpful to review briefly the history of the locomotor system. This will show us how environmental changes made necessary the many modifications and adaptations of these joints and will lead us to a better understanding of the relationship between present-day environment, morphology, and pathology.

Originally all animals, including vertebrates, lived exclusively in the water and moved by sending waves of contraction along the muscular segments of their bodies. Fins were projections of the skin or body wall and functioned in maintaining balance and steering the tapered bodies.

As water became shallower in some areas, certain fishes adapted themselves to swamp life, breathing air and using fins as paddles and then as limbs to crawl along the muddy banks. In search of food they climbed higher and higher, and after many millions of years gradually developed limbs like turtles and lizards that raised their bellies off the ground. The higher they climbed, the longer their limbs grew and the more complicated became their joints. Eventually they learned how to run along the ground very swiftly and to climb trees and to swing from branch to branch. Swamps, jungles, forests, deserts, prairies, mesas, mountains, and climatic changes necessitated modifications and adaptations of limb and body. As nature worked out some marked improvement, this device would be bequeathed to many diversified descendants. Thus the bodies of the more recently evolved animals came to have many structures—most of them of utmost importance, some of doubtful value—inherited through the will of bountiful nature from myriads of ancestors who fought a life-and-death struggle to acquire them.

The simplest present-day vertebrate having a knee joint is the amphibian, of which the *salamander* is a good example. This animal has a long

* Read before the Jacobi Medical Society, Washington, D. C., in March 1937, and the Orthopaedic Section of the New York Academy of Medicine, New York, N. Y., in May 1937.

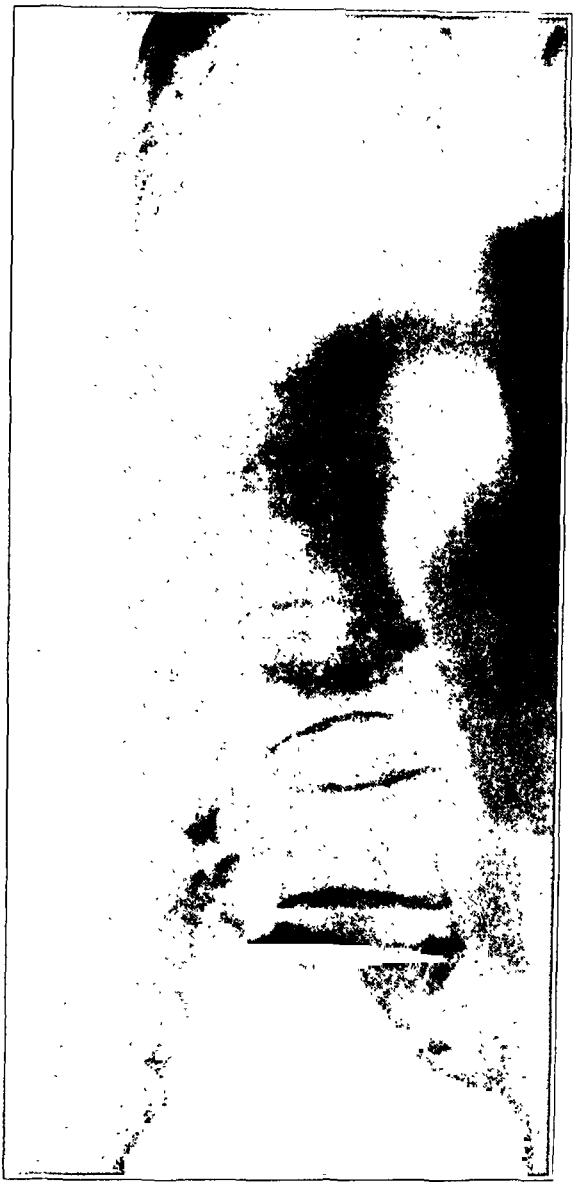


FIG. 1

Generalized osteoporosis (cause unknown). Note the compression of isolated vertebrae without a history of accident.

becomes shiny, the parts are swollen, and the tenderness is severe on the lightest pressure. The local temperature in the early stages may be elevated, but later the skin feels cold and assumes a bluish color. At this later stage, there is an increase in the swelling, and the stiffness limits motion to a varying degree. In a few instances, small superficial abscesses have formed, but trophic changes have not been observed. In no instance did a purulent arthritis develop.

In acute osteoporosis with symptoms, the roentgenographic appearance is more or less characteristic. The cortex is fairly well preserved. The medullary portion gives a mottled, moth-eaten shadow, and the longitudinal trabeculae are not so well defined as in the other type. If the long bones are involved, the demineralization usually affects the entire shaft (Fig. 11) and is not limited to the ends of the bone as one observes in relation to fractures and to joint infections.

The course of the disease is characterized by persistent pain and a marked loss of function which does not respond to any form of treatment. After many months or even years (in one case the foot was totally disabled for two years) the symptoms may subside, but the prognosis is so uncertain that the condition has been grouped with the "self-limited diseases".

The cause of osteoporosis is not known, and any discussion of this phase of the lesion only leads one into a field of theories and hypotheses of the relationship of circulatory, nervous, chemical, inflammatory, and endocrine influences to the bone change as revealed by the roentgenogram. Osteoporosis is only one more of the many unexplained phenomena of bone, that tissue which is perhaps the most fluid and which is the most easily influenced of all body tissues. The reading of the literature on bone demineralization is interesting, but yields no definite conclusions.

The pathology of the osteoporotic bone has been studied in but few instances, as rarely is there an indication for operation or an opportunity for post-mortem examination. Gurd found the haversian canals to be much widened and the cortex thin. Fontaine and Herrmann in gross examination of porotic bone found the cortex to be brittle and the medullary portion almost completely replaced by adipose tissue.

That the treatment of osteoporosis with symptoms has been most unsatisfactory may be conceded. No plan suggested has given universal success. Heat in all forms, partial and complete fixation, massage, active use, and passive manipulation have, in the author's experience, all failed. Periarterial sympathectomy (Leriche), nerve blocking (Turner), minimum of immobilization followed by active movement (Sudeck), heat and light massage (Noble and Hauser), thyroid and parathyroid extracts (Delorme), heliotherapy (Peck), elevation of the affected part followed by the application of a light plaster splint (Gurd), and administration by ionization of parasympathetic stimulants (Middleton) are some of the suggestions for treatment. The variety and the number of these suggestions indicate their value.

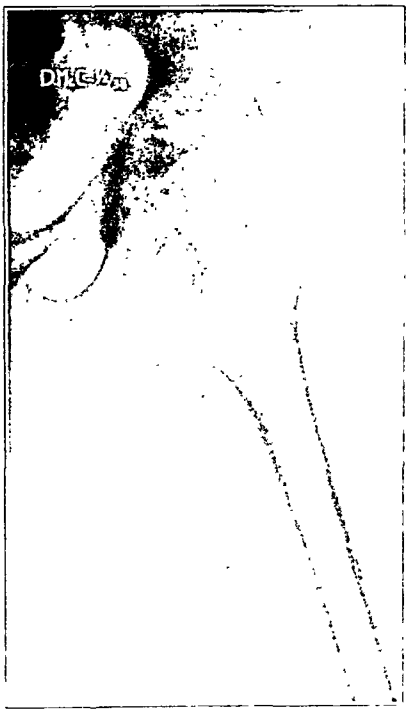


FIG. 2

Osteoporosis following tuberculosis. Note the thin cortex.

The use of roentgenotherapy in osteoporosis was suggested to the author as an empirical form of treatment by the report of Turner, who relieved his patients by injecting the sensory nerve to the affected part with alcohol, and by the report of Kahlmeter of his experience with roentgenotherapy in arthritis. If osteoporosis is caused by some chemical substance liberated at the terminals of the sensory nerves in the bone tissue when these nerves are stimulated (pain) by some extraneous and unknown cause (inflammation), upon which theory Turner based his nerve blocking, and if roentgenotherapy (the analgesic effect possessed by the roentgen ray, although unexplained, is common knowledge) will relieve pain, the use of roentgenotherapy in osteoporosis is an apparently rational form of treatment. The results obtained in a few cases through roentgenotherapy were so startling that this preliminary and perhaps abortive report is presented in order that other surgeons may follow the suggested plan of treatment and either prove or disprove its value. It must be understood that relief was not



FIG. 3

Case 1. Two weeks after injury. There is no atrophy. Note the fracture line in the navicular.

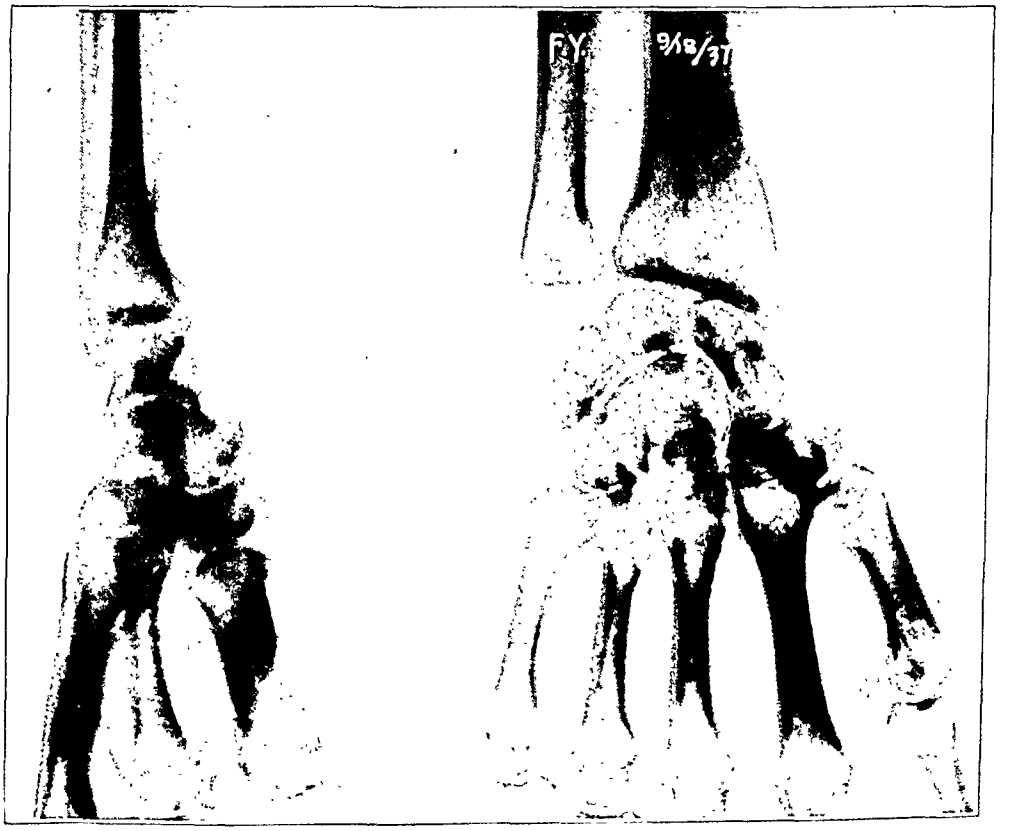



FIG. 4

Case 1. Five weeks after injury. Acute osteoporosis.



FIG. 5

Case 1. Three months after roentgenotherapy. Note the increased density in the bone.

obtained in all cases. However, roentgenotherapy can be advised on the basis that it may do some good and that it will not do any harm, as the dosage is not sufficient to produce an erythema.

The dosage is that suggested by Kahlmeter (Stockholm) and his article is quoted as follows:

"The tube output is 173 kw. (kilowatt) at a current of 6 milliamperes, and the filter used is equivalent to 0.5 Cu I Al. The focal distance is 30 cm., except for fields the size of 15 to 20 cm., where we use 40 cm. The field generally used measures 10 to 15 cm., although 8 to 10 cm. is also employed. With the above technique I SED in a field of 10 to 15, is equal to 1,000 r. . . . It will be seen, therefore, that in most cases we give in one series single doses of 150 to 200 r (1/7 to 1/5 SED), repeated two to three times at an interval of two to three days. After the lapse of four to six weeks we give, if needed, a second series of treatment of exactly the same dosage, and sometimes after still another six to eight weeks a third series of irradiations."

The following cases are reported with full knowledge that the number is small. It will be noted that the treatment in Case 6 not only resulted in failure, but the condition progressed during the time that roentgenotherapy was used.

Cases 4 and 5 brought out another subject for discussion. In each of these cases not only was the pain relieved, but, without any other form of treatment, the stiffness and loss of function in the joints disappeared




FIG. 6

Case 1. Six months after roentgenotherapy. In comparison with the normal right hand, the left hand still shows involvement.

entirely. Each of these cases was associated with an inflammatory process, and the complete recovery suggests that in this type of lesion the stiffness is not due to adhesions in and about the capsules and tendons, but is entirely the result of muscle spasm, and that when the pain is relieved the muscle spasm disappears and function is returned. This thought has been supported further in a few cases of low-back ache in which complete relief of symptoms has followed roentgenotherapy.

## CASE REPORTS

CASE 1. (*Figures 3, 4, 5, and 6.*) F. Y., female, aged twenty-six years, a cashier in a drug store, fell and injured the left wrist on July 5, 1937. At that time the injury was considered a sprain and the wrist was merely strapped and carried in a sling. Two weeks after the accident the patient was first examined by the author. Roentgenographic examination showed a fine line in the navicular, which the author considered to be a fracture. There was no osteoporosis at that time.

The hand and forearm were placed in a plaster splint for fixation. The next week the patient complained of constant pain and aching both day and night, which was so severe that a narcotic was necessary. After ten days of fixation, the splint was removed and roentgenographic examination revealed a very marked osteoporosis in the bones of

the wrist and hand. At this time the hand was swollen and dark red in color. The local temperature was lower than that of the opposite side; there was almost complete loss of motion in the wrist and fingers; and the patient complained of exquisite pain in the wrist and especially in the little and ring fingers. Any attempt to move the fingers or wrist caused marked pain.

Roentgen-ray treatments were given, and almost immediately there was a return of normal color to the skin. The swelling disappeared, and function returned to the fingers and wrist, so that the patient was able to resume her duties ten days after the last treatment. However, she still had some pain, especially in the little and ring fingers.

This patient has been observed on several occasions since the roentgen-ray treatments and there has not been any return of the severe symptoms, but she still has some pain and discomfort in the little and ring fingers, although not sufficient to keep her from working. She states that with this hand she has used the cash register on an average of 1,500 times a day.

This case was settled before the Industrial Board on the basis of 10-per-cent. permanent partial impairment to the hand as a whole.

CASE 2. H. H., male, aged twenty-six years, a machinist, on August 6, 1937, sprained the left foot through a simple twist. At that time there was no abrasion on the foot, but it became quite swollen, and five days later his physician made an incision over the dorsum of the foot. There was some drainage of a serous exudate for a period of about three weeks, and then the wound became healed. Associated with the swelling was severe pain, which was practically constant day and night and was aggravated whenever the patient attempted to do any work or to bear any weight or had any pressure on the toes.

This patient was examined by the writer on November 16, 1937, three months after the initial injury. He stated that he had not been able to do any work since the date of the accident on account of the pain in his foot.

At the time of the examination, the foot was swollen, the skin was glossy, and the temperature of the foot seemed to be somewhat below that of the opposite side. The mid-foot, especially, was very tender to even the slightest pressure. Motion in the ankle joint, in the mid-tarsal region, and in the toes was very much limited, and any attempt to produce motion caused the patient to complain of pain. Roentgenographic examination showed a marked osteoporosis involving the bones of the foot.

This patient was given a series of roentgen-ray treatments. Within a day or two following the last treatment, the swelling had entirely disappeared, the color of the foot had returned, the patient was free from pain, and there was but very little loss of function in the foot as a whole. This patient was observed several times, the last occasion being on March 1, 1938, and upon that date the foot was normal in appearance, there was no circulatory disturbance, and the patient had only slight pain upon weight-bearing.

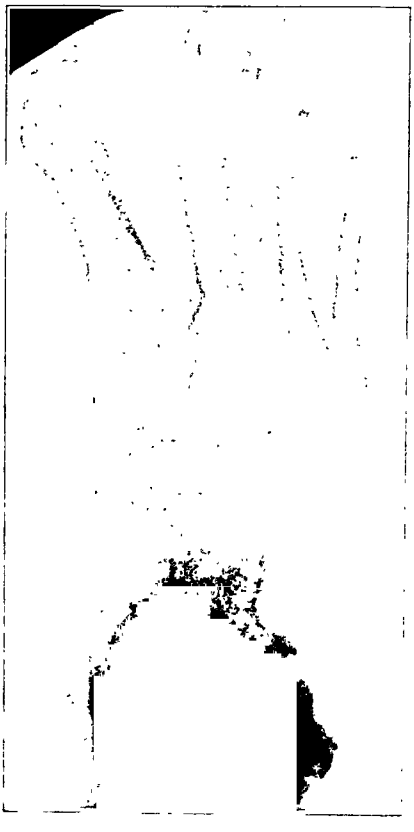


FIG. 7

Case 3. Osteoporosis of the tarsal bones.

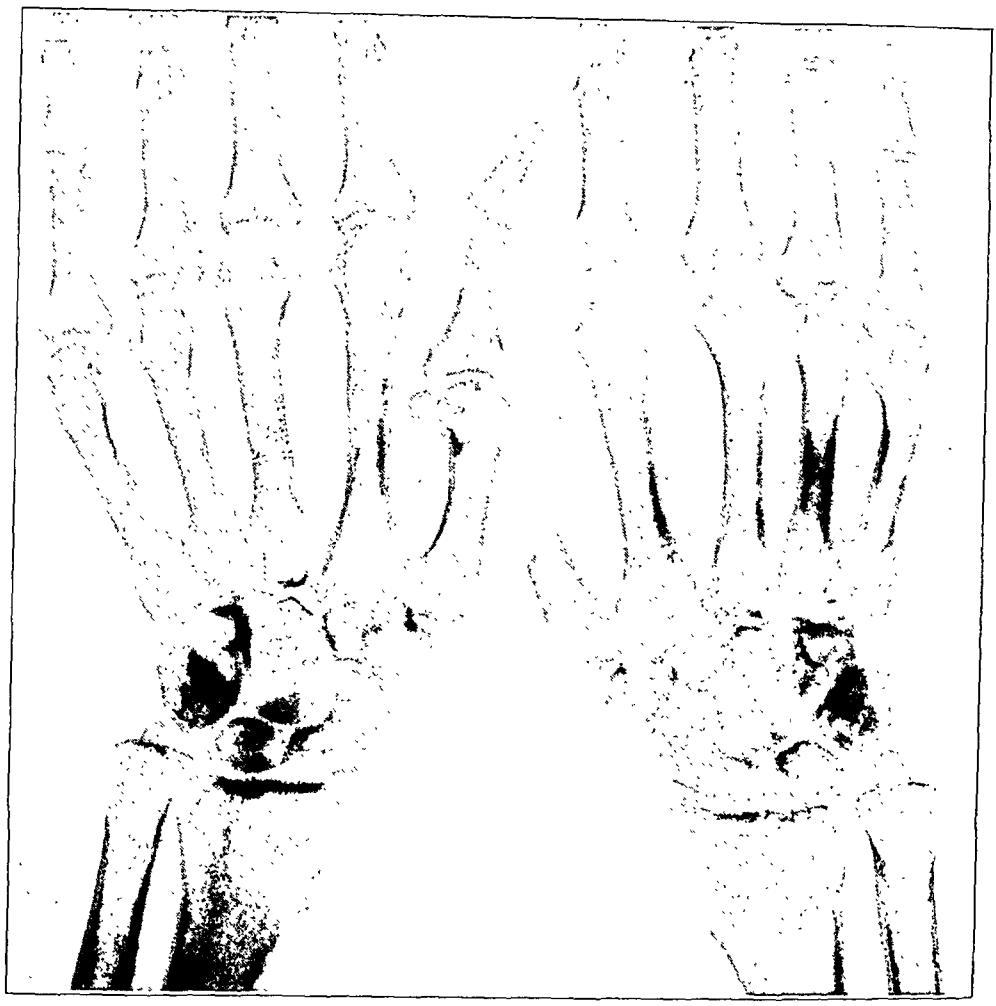


FIG. 8

Case 4. Acute osteoporosis following infection and amputation of the thumb. Complete return of function followed roentgenotherapy.

This case was settled before the Industrial Board on a basis of 10-per cent. loss of the foot as a whole, this impairment being due to some slight pain upon weight-bearing.

CASE 3. (*Figure 7.*) R. E., male, aged thirty-two years, a fireman, on October 14, 1937, while sliding down a pole, landed with considerable force, causing an injury to the right ankle. At that time he did not consider the condition to be serious, but the following day he began to have pain and swelling in the foot and was unable to work as a fireman after that time.

Roentgenographic examination showed a possible fracture of the second cuneiform bone.

Upon examination, on December 18, 1937, the foot was swollen and bluish in color, the temperature was lower than that of the opposite foot, there was considerable loss of motion in the ankle joint as well as in the mid-dorsal region of the foot, and the patient complained of tenderness to the slightest pressure over the entire foot. Roentgenograms taken at that time showed a very marked demineralization of the mid-tarsal bones of the foot.

This patient was given roentgen-ray treatments and was able to return to his work at the end of two weeks. Upon examination on March 1, 1938, he was at work as a fireman and had but very little pain in the foot as a whole.

CASE 4. (*Figure 8.*) H. G., male, aged fifty-seven years, a laborer, on September 16, 1937, struck a piece of brick with the right thumb, causing a compound fracture of

the phalanx. One week later, infection developed, and one month after the accident, the thumb was amputated at the metacarpophalangeal joint. Following this amputation, there was considerable swelling in the hand as a whole and also in the wrist. This patient was first seen by the author on December 22, 1937. He complained of very marked pain in the wrist and hand as a whole, and there was at least 90-per cent. loss of function in the fingers and wrist through loss of motion in the joints. The hand was described by his wife as looking like that of a dead person, being of a light bluish cast, cold, and extremely tender to touch.

Roentgen-ray treatments were instituted and after the second dose the color of the hand became normal and the pain became less severe. One week after the last treatment had been given, the patient was entirely free from pain, the color of the hand was good, swelling had disappeared, and there was only about 25-per cent. loss of function in the fingers and wrist. At the end of two more weeks, this patient had a normal hand so far as the fingers and wrist were concerned, both as to function in the joints and as to relief from pain, except for some tenderness over the amputation stump.

This patient was seen again on March 1, 1938, and at that time he had a normal hand and wrist, with the exception of the loss of the thumb, and he was able to do any work that was possible in view of the absence of the thumb.

CASE 5. (*Figures 9-A and 9-B.*) J. H., male, aged nineteen years, a laborer, on August 27, 1937, sustained a compound fracture of the left calcaneum. This was an extensive compound crushing wound, and the entire lateral side of the heel sloughed away with loss of some of the bone substance of the body of the calcaneum. The patient was treated by his local physician until November 26, at which time he was referred to the author for examination and treatment.

The patient complained of constant pain and aching in the foot, together with considerable loss of motion in the ankle joint and in the foot as a whole. For many weeks he had had to use amytal to obtain sleep. There was a large ulcer, or granulating wound, on the outer side of the heel, and he was sent to the hospital for treatment. At that time the writer suggested that he be given roentgen-ray treatments for the cleaning up of the skin in preparation for a future skin graft. After the third treatment, the patient stated that the pain had almost entirely disappeared from the foot and that function had returned to a very considerable degree. He was given further roentgen-ray treatment, and a skin graft was done. He was discharged from the hospital at the end of one month, at which time the skin graft had covered over the granulating area.

This patient has been observed frequently since the roentgen-ray treatments were given, and on March 1, 1938, he was practically free from pain in

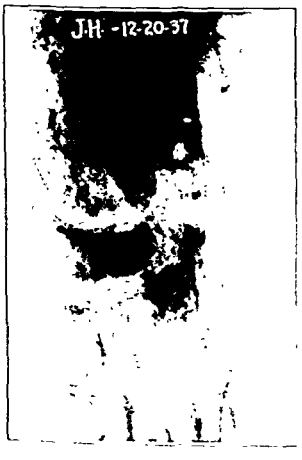



FIG. 9-A



FIG. 9-B

Case 5. Acute osteoporosis following compound fracture of the calcaneum. Complete return of function followed roentgenotherapy.



FIG. 11

Case 6. Acute osteoporosis of ulna, radius, and humerus.




FIG. 10

Case 6. Acute osteoporosis following Colles' fracture. Roentgenotherapy was of no value. (See Fig. 11.)

the foot except upon weight-bearing, and then the pain was not extreme. He is able now to walk without a cane or crutch. Motion in the foot is practically normal.

CASE 6. (*Figures 10 and 11.*) G. C., female, aged fifty-five years, a maid, fell on December 27, 1937, and fractured the lower end of the radius (Colles' fracture). There was a considerable amount of impaction. Two attempts at reduction under local anaesthesia were made, but full length of the radius was not obtained, although the articulating surface of the radius was restored to normal position. From the time of the accident the patient had considerable pain in the wrist with swelling of the wrist and hand. Fixation was maintained for four weeks with no cessation of pain. Subsequent roentgenograms showed an osteoporosis of the carpal bones and lower portion of the radius and ulna. Roentgenotherapy was given without any relief of pain. The splints were removed at the end of the fifth week. There was considerable loss of function in the fingers and wrist; the parts were swollen and very tender; and the skin was shiny and of a bluish cast.

About the sixth week, the patient complained of pain in the forearm and upper arm. Roentgenograms taken at that time showed a moderate degree of osteoporosis of the shafts of the humerus, radius, and ulna and a very marked thinning of the shadow of the bones of the hand and wrist. A second course of roentgenotherapy proved to be of no value. The patient now (at end of four weeks) is somewhat improved under short-wave diathermy and dry heat, but the hand and wrist are slightly swollen and the function of the fingers is greatly impaired. Most of the pain is now in the upper arm. This case did not respond to treatment of any type.

## CONCLUSIONS

1. Osteoporosis should be classified as being with or without symptoms.

2. The type with symptoms (the acute bone atrophy of Sudeck) responded to roentgenotherapy in five out of six cases treated.

3. The roentgen-ray dosage is of such a type that erythema or burns will not occur.

4. In some cases of loss of function in joints associated with an inflammatory condition of the adjacent soft parts, the roentgen-ray apparently relieved the pain which was producing muscle spasm, and function of the joint returned.

5. The suggested roentgenotherapy for osteoporosis is purely empirical, and further proof of its true value is necessary.

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# A REVIEW OF THE CAMPAIGN FOR THE ESTABLISHMENT OF SURGICAL PRINCIPLES IN THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR

BY ROYAL WHITMAN, M.D., NEW YORK, N. Y.

At the beginning of this century, fracture of the neck of the femur was a therapeutic derelict. The futility of conventional treatment, demonstrated by Sir Astley Cooper, had been accepted as a finality and permanent disability as an inevitable sequence of the injury.

The clue which was to indicate the way of escape from this therapeutic Slough of Despond came to light in 1890 when the writer identified a case of fracture of the neck of the femur in a child. This was reported as a surgical curiosity, since at that time the injury was regarded as an attribute of old age.

In succeeding years, a number of similar cases were brought to the hospital for the treatment of hip disease, for, although in each instance the fracture had united, a limp and discomfort persisted. The x-ray was not then available for diagnosis, but the elevation of the trochanter, indicating a corresponding depression of the neck, afterward called "coxa vara", demonstrated the mechanical nature of the disability. This was remedied by the removal of a sufficient wedge of bone from the base of the trochanter to restore the range of abduction.

This experience was enlightening, for it demonstrated the direct relation of the inclination of the neck of the femur to the normal gait. It was further evident that, if the angle of the neck could be restored by this indirect method, the characteristic deformity in this class of cases might be easily corrected at the time of the injury by adjusting the shaft to the neck,—namely, by abducting the limb and rotating it inward.

It then appeared, on further investigation of the mechanics of the joint, that the same manoeuver would be equally effective for the treatment of a complete fracture of the neck proper, for abduction and inward rotation of the limb after the shortening had been reduced would appose the fragments in a horizontal plane, while tension on the enclosing capsule would force a resistant contact.

It was evident, furthermore, that muscle action, which Sir Astley Cooper had found impossible to control, was entirely eliminated as an agent of displacement. It remained, therefore, only to support the limb in full abduction and extension by a plaster spica to assure the security of the internal splinting.

Thus it appeared that by the utilization of anatomical mechanics the opportunity for functional repair might be assured for all types of fracture at the hip.

Although the efficiency of what was called from its most salient feature the "abduction method" could be easily demonstrated, it made

little impression on a profession taught "that the ideal object of treatment, restoration of form and function, was rarely to be attempted or even sought".

Neglect of the fracture in the alleged interest of the patient entailed no responsibility, either moral or legal. Positive treatment, by contrast, could appeal only to adventurous spirits, since the correction of deformity might "break up the sacrosanct impaction", the only hope of union, while the restraint of the plaster spica must endanger the life of the patient.

Furthermore, the command of anatomical mechanics for the attainment of a definite object, to be supplemented by the construction of a comfortable and efficient plaster support, called for a much higher standard of technical preparedness than had ever been available in the treatment of this neglected injury.

During the lapse of years, however, in spite of opposition and inertia, the abduction treatment has come into general use, and experience has disproved every assumption on which the negative doctrine was based. It has been demonstrated not only that repair of the transcervical fracture, in the large proportion of the cases, is assured when opportunity is given, but also that positive treatment of the fracture is the most conservative treatment of the patient.

Paradoxical as it may seem, the plaster spica, which has always borne the brunt of the adverse criticism of the method, has proved to be the most effective means of fulfilling what was considered "the first consideration, to save life" by relieving pain and preventing bedsores and hypostatic congestion, the most dangerous complications of the injury. Successful results in the eighth and ninth decades of life have become commonplace and one such case has been reported in a patient aged 102.

Finally, the anatomical method, which is effective both in reducing resistant deformity at the base and in adjusting displaced fragments of the neck proper, is equally comprehensive in its practicability. Since it requires neither elaborate apparatus for its application nor the cooperation of skilled nursing, it has proved effective under the hard conditions of domestic practice, even in inexperienced hands.

The spiking operation, with which the abduction method is often contrasted to its disadvantage, dates from preabduction days when it was considered the only means of fixing the fragments. It was revived in recent years by Smith-Petersen on the logical proposition that, since the capacity for repair of the transcervical fracture had been so amply demonstrated, the percentage of failure might be materially reduced by open exposure, accurate adjustment of the fragments, and secure fixation by his flanged nail.

The open operation has now been displaced by the indirect method, introduced by Johansson, in which, after the fragments have been adjusted by abduction mechanics, the flanged nail is inserted through a small incision at the base of the trochanter. Thus, since this method

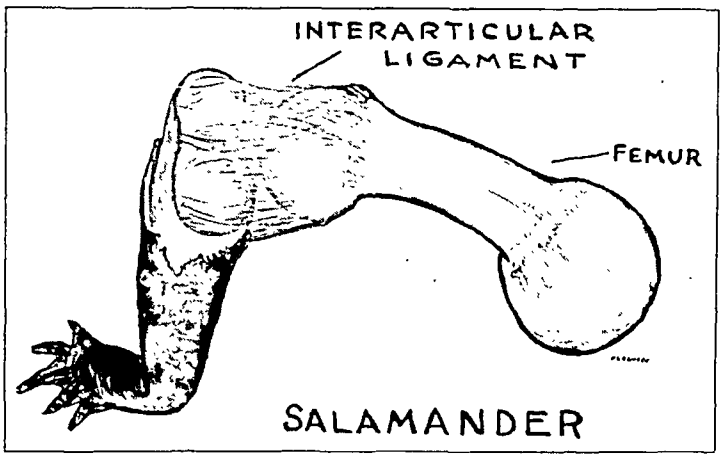



FIG. 1

reptilian body with very small limbs. The knee joint consists of the round condyles of the femur and the single tibiofibula with a simple thin interarticular membrane which is probably a synovial lining. No menisci nor cruciate ligaments are to be made out. There is no patella, the extensor muscles ending in a ligament which passes over the joint to insert in the shin bone.

The *frog* has very long hind limbs capable of considerable activity. The knee joint is not unlike that of the salamander just described except that the interarticular membrane when stretched out presents two crescentic thickenings suggestive of menisci. There is no cartilage in this membrane even where the thickenings occur. It is rather remarkable that this is the first indication of the morphology which in the more highly developed animals will shape the semilunar cartilages. No patella is present.

The reptilia show considerable advance in the development of the limbs and especially of the knee joint. The *alligator* which was dissected has two bones,—a tibia and a fibula. The condyles of the femur are more pronounced, so as to give a pulley-shaped appearance. The upper end of the fibula is enlarged and prolonged, so as to articulate with the lateral tuberosity of the femur. Definite cartilaginous menisci are present and seem to arise from the transverse ligaments of the joint. The lateral meniscus has a secondary cartilaginous ring which is attached to

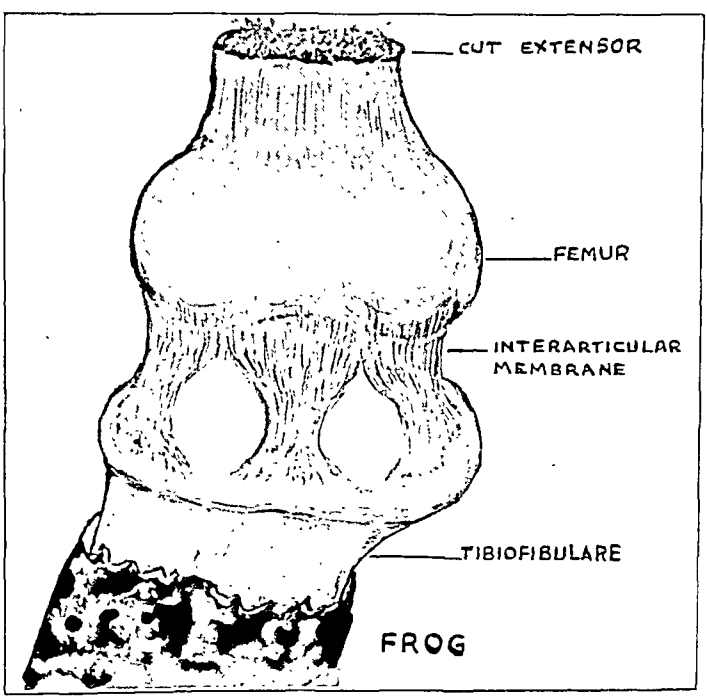



FIG. 2

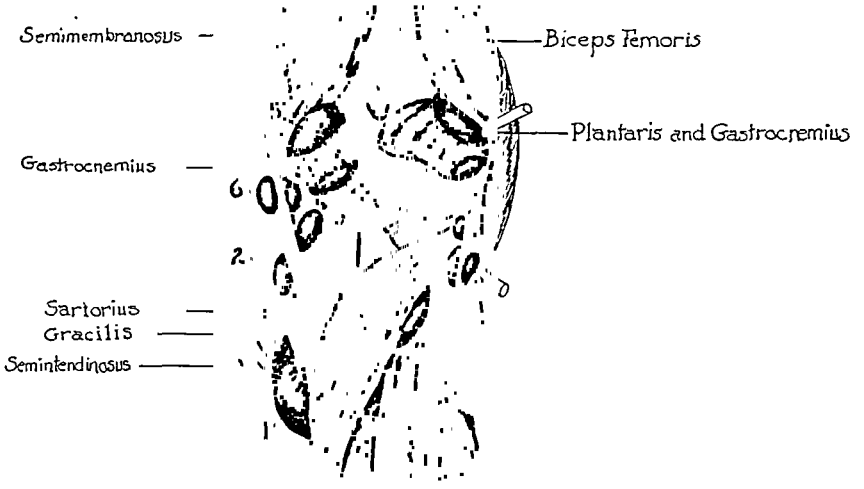



FIG. 1

Right popliteal space, showing bursae. (Modified from Callander.)

Spalteholz explains the confusion over the term semimembranosus bursa: "Bursa m. semimembranosi, constant, double; one between the m. semimembranosus and caput mediale m. gastrocnemii, in front coming in contact with the capsule of the joint (it may communicate with the joint); the other, between the tendon of the m. semimembranosus and the condylus medialis tibiae." These comprise in our list *5* and *3*, the latter frequently communicating with *2*. The frequency with which the bursa under the inner head of the gastrocnemius communicates with the joint is estimated by Foucher and Gruber (quoted by Piersol) as 50 per cent. or more of the cases. All the authorities readily agree that this bursa frequently communicates, although some (Piersol, Morris) add some reference to adult life.

Through the courtesy of the Department of Anatomy of Columbia University, we were able to dissect the popliteal fossae of thirty cadavera in order to study these bursae in connection with the semimembranosus and the inner head of the gastrocnemius. In twenty-six cases, we found this composite bursa which we may call the gastrocnemio-semimembranosus bursa. This presented very superficially between these two muscles and sometimes was in contact with the deep fascia of the popliteal space (Fig. 2). The irregular, lax, superficial portion was approximately one to one and one-half inches long and one-quarter of an inch across, with its long axis corresponding with the outer border of the semimembranosus. This part was loosely attached to the fatty areolar tissue intervening between the deep fascia, the tendon, and the muscle. The deeper part of the bursa was intimately attached to the tendon of the semimembranosus and to that of the inner head of the gastrocnemius, for the under surface of this latter muscle was tendinous where it overlay the capsule over the upper part of the medial condyle of the femur. The

must utilize anatomical mechanics to appose the fragments, it may be classed as a complement to the abduction treatment, substituting artificial for natural splinting. It has the advantage over the open operation in its comparative freedom from danger, and the percentage of union is materially higher because of less interference with nutrition. Its most attractive feature from the standpoint of the patient is comparative freedom from restraint: "In a few hours the patient is ready for a wheeled chair and may at once, if so disposed, enjoy the use of crutches." This introduces the question of function as influenced by treatment.

The essentials of a normal gait are a sufficient range of abduction and extension. Even after the limb has been fixed for weeks in extension and abduction, it has been found necessary to carry out in the after-care a routine of what the patients call "stretching" in these directions, until voluntary control has been restored.

From this personal experience it may be questioned if the flanged nail will so suppress the sensitiveness of the injured part as to permit locomotion, weight-bearing, and the habitual assumption of the sitting posture during the period of repair and yet check the tendency toward flexion and adduction so characteristic of injury or disease at the hip joint.

The purpose of this final paper is set forth in its title. The fact that what was formerly the most neglected of all fractures can now command the technical skill required for the spiking operation is conclusive evidence that the campaign which has been carried on for upwards of half a century has been successfully concluded.

relations described for the gastrocnemio-semimembranosus bursa, the septum passing across from the capsule medially to the deep surface of the inner head of the gastrocnemius within a few millimeters of its inner border. The septum took a relatively oblique course in passing from the anterior to the posterior wall of the composite bursa, so that it lay almost in the coronal plane.

Out of the thirty specimens dissected, all of which were in adult cadavera, we found communication with the joint in seventeen, two of these being communications with the independent bursa under the inner head of the gastrocnemius. The semimembranosus component, when separate, was never found to communicate with the joint, and the communication was always located in that part of the composite bursa contributed by the bursa under the inner head of the gastrocnemius. It was found high up under the origin of the inner head of the gastrocnemius, above and medial to the oblique popliteal ligament, and was rarely smaller than one-half an inch in diameter. There was, of course, no neck or stalk, as the anterior wall through which the communication occurred consisted only of the posterior capsule lined with synovial mesothelium on one surface and bursal mesothelium on the other. The edges were greatly attenuated, and, since the color of the smooth bursa-covered capsule was almost identical with that of the condylar cartilage, the perforation was not always recognized until the knee was flexed and the capsule was induced to separate from the subjacent condyle. The situation of this gastrocnemio-semimembranosus bursa in relation to the bones is illustrated in the roent-

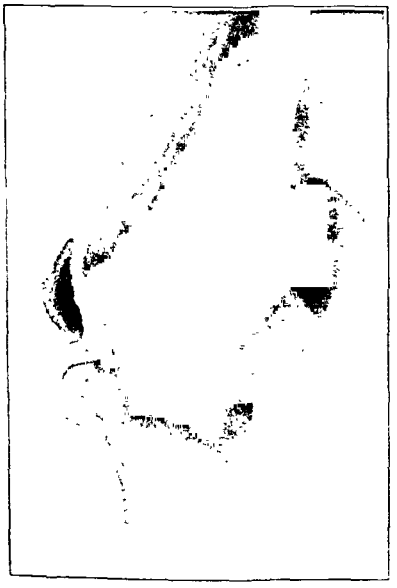


FIG. 4-A

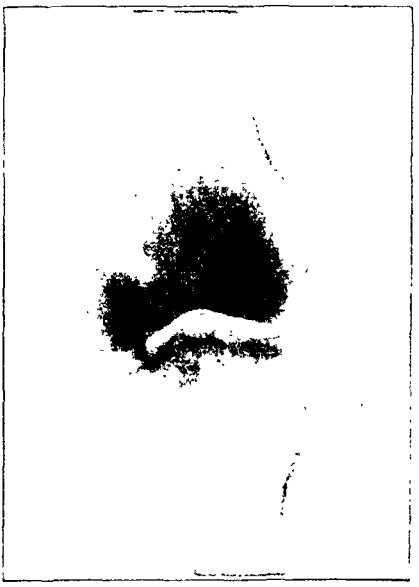


FIG. 4-B

Roentgenograms of left knee of cadaver with gastrocnemio-semimembranosus bursa injected with paraffin and lipiodol.

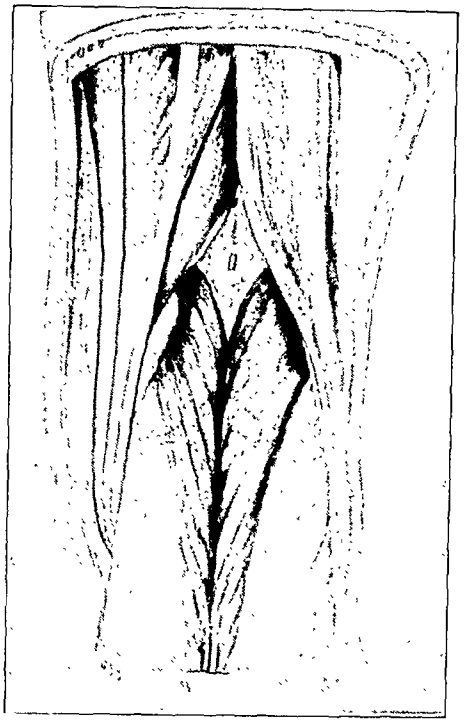


FIG. 2

Superficial view of anatomy of gastrocnemio-semimembranosus bursa.

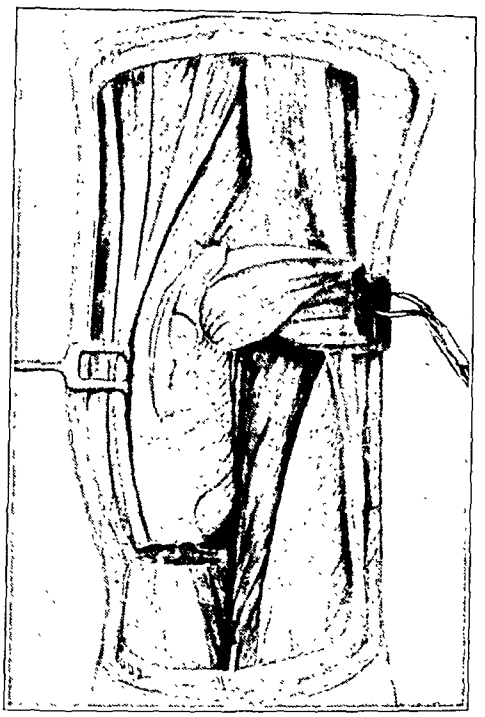


FIG. 3

Deep view of anatomy of gastrocnemio-semimembranosus bursa, showing inner head of gastrocnemius cut inferiorly and retracted upward. The bursa is laid open and is seen to be adherent to the two muscles and to the capsule. The communication with the knee joint is seen at the upper extremity of the bursa.

proximal portion of the bursa was usually found to extend around the inner border of the origin of the inner head of the gastrocnemius, covering it superficially as well to about one-quarter of its width. Distally, the bursa reached the inner tuberosity of the tibia. In tracing it transversely, the bursa invested the contiguous margins of the two muscles, spreading over their deep surfaces, and was then reflected onto the capsule of the knee joint. In its lower third the bursa also lined and was adherent to the superficial surface of the tendon of the semimembranosus. When the inner head of the gastrocnemius was cut inferiorly and the upper portion was elevated (Fig. 3), it was seen that the bursa was not closely adherent to the more muscular lower part of the under surface of the gastrocnemius, but it became detached and bridged the interval between the elevated muscle and the posterior capsule of the joint, to which it was firmly attached. The portion of this bursa passing downward, forward, and inward under the tendon of the semimembranosus came near to the bursae surrounding this tendon at its insertion (*2* and *3*), but in the material dissected no communication was found. The bursa frequently showed septa, apparently representing its composite origin. In four cases, there were two separate bursae,—one the semimembranosus bursa (*5* in the list), and the other the bursa under the inner head of the gastrocnemius (*4*). When the septum was incised, the two bursae together were found to have the

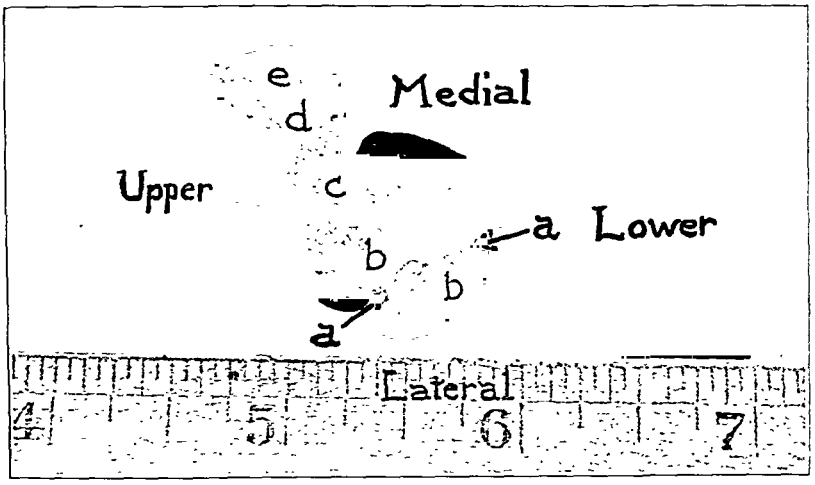



FIG. 6-A

Cast of left gastrocnemio-semimembranosus bursa to show pronounced septum. Superficial view.

*a:* Septum incompletely dividing the bursa with its component primary parts.
*b:* Portion covered by inner head of gastrocnemius.
*c:* Superficial portion of bursa.
*d:* Groove for tendon of semimembranosus.
*e:* Portion of bursa medial to tendon.
*f:* Deep surface in contact with capsule.

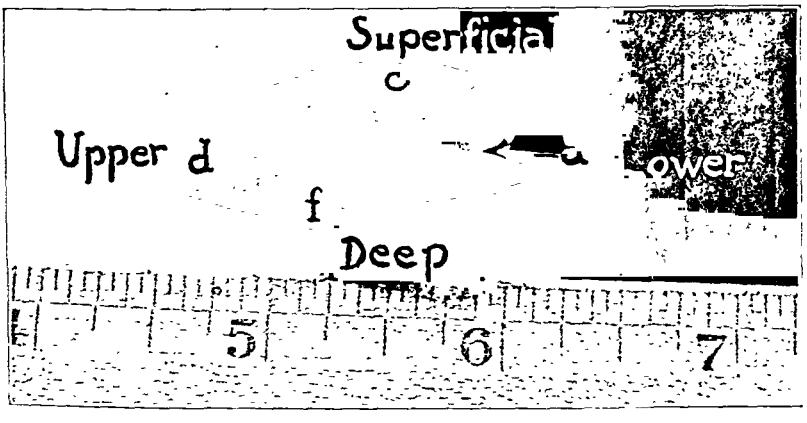



FIG. 6-B

Cast of left gastrocnemio-semimembranosus bursa to show pronounced septum. Lateral view.

the communication with the knee joint is well shown, and in the other (Figs. 6-A and 6-B), the presence of the septa is clearly evident.

## REVIEW OF THE CLINICAL MATERIAL

A search of the records of the Hospital for the Ruptured and Crippled revealed that between the years 1926 and 1938 twenty-one patients had been subjected to operation with the diagnosis of popliteal cyst. (See Table I.)

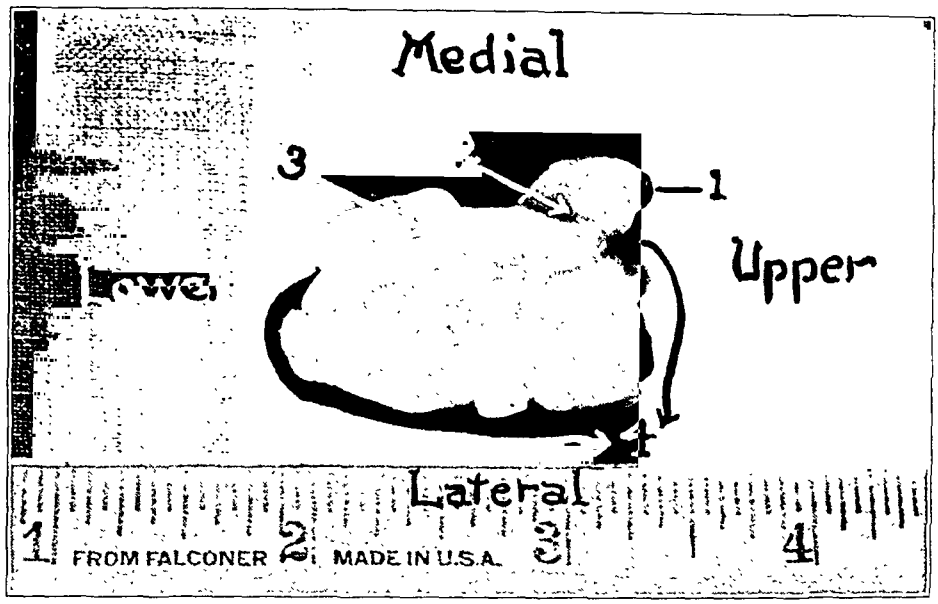



FIG. 5-A

Cast of right gastrocnemio-semimembranosus bursa. Posterior or superficial view.

*1:* Portion of bursa medial to semimembranosus tendon.
*2:* Groove for semimembranosus tendon.
*3:* Superficial portion of bursa appearing between semimembranosus and inner head of gastrocnemius.
*4:* Part covered by inner head of gastrocnemius.
*5:* Area of communication with knee joint bounded below by *6*.
*6:* Groove formed by capsular edge.
*7:* Portion of bursa in contact with capsule.

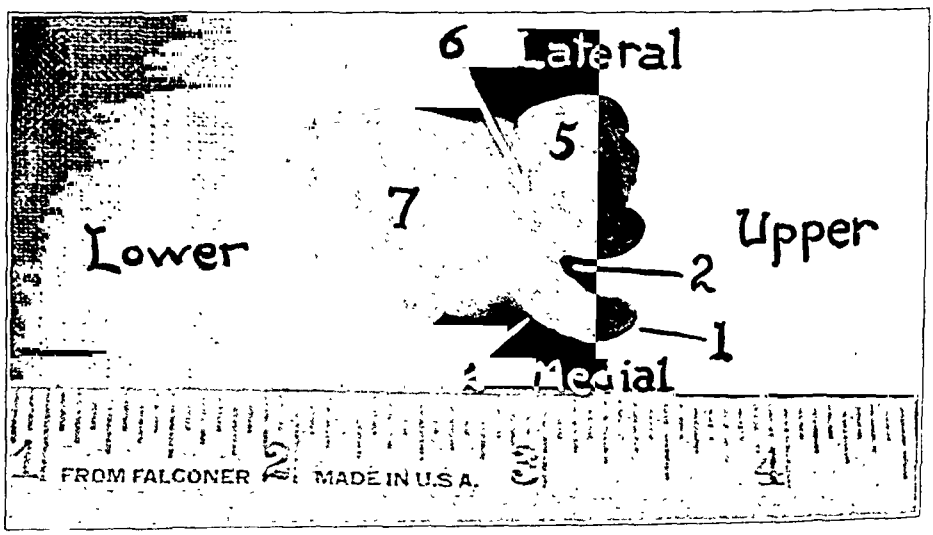



FIG. 5-B

Cast of right gastrocnemio-semimembranosus bursa. Anterior or deep view.

genograms (Figs. 4-A and 4-B) made when the bursa in a cadaver was injected with a mixture of lipiodol and paraffin. The paraffin casts were dissected out and photographed. Two (Figs. 5-A, 5-B, 6-A, and 6-B) are illustrated here and show the grooves for the semimembranosus tendon and the medial head of the gastrocnemius. In one (Figs. 5-A and 5-B),

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A. L. B. | Female | 50 | Left | Knee and cyst | None | Osteo-arthritis | May 1935 | Yes | Medial: Semimembranosus<br>Lateral: Inner head of gastrocnemius | No recurrence. Some aching in knee. |
| M. G. | Female | 64 | Left | Knee and cyst | Present | Osteo-arthritis | January 1936 | Yes | Medial: Semimembranosus<br>Lateral: Gastrocnemius | No recurrence. Both knees cause complaints. |
| D. O'L. | Male | 53 | Right | Cyst | None | Normal | September 1936 | | "From region of inner condyle" | |
| P. V. | Male | 5 | Right | Cyst | None | | September 1936 | No | "Originated from semimembranosus bursa" | |
| S. d'A. | Male | 57 | Left | Knee and cyst | | Osteo-arthritis | February 1937 | Yes | | |
| S. K. | Male | 37 | Left | Knee and cyst | | | April 1937 | Yes | Medial aspect of popliteal space | No recurrence. No complaints. |
| F. I. | Male | 47 | Right | Knee and cyst | Present | Charcot's knee | April 1937 | Yes | Medial aspect of popliteal space | No recurrence. Brace for unstable knee. |
| E. B. | Female | 49 | Left | Knee and cyst | None | | September 1937 | Yes | | No recurrence. Knee fairly comfortable. |
| T. S. | Female | 60 | Right | Knee and cyst | None | Normal | November 1937 | Yes | Medial: Semimembranosus and semitendinosus<br>Lateral: Gastrocnemius | Recurrence. |
| R. P. | Female | 62 | Right | Knee and cyst | None | Normal | February 1938 | Yes | Medial: Semimembranosus<br>Lateral: Inner head of gastrocnemius | |
| A. V. | Male | 5½ | Right | Cyst | None | Normal | March 1938 | Yes | Medial: Semimembranosus<br>Lateral: Inner head of gastrocnemius | |
| L. W. | Male | 73 | Right | Knee and cyst | Present | Osteo-arthritis | April 1938 | Yes | Medial: Semimembranosus<br>Lateral: Inner head of gastrocnemius | |

TABLE I

ANALYSIS OF TWENTY-ONE CASES IN WHICH OPERATION WAS PERFORMED FOR POPLITEAL CYST BETWEEN 1926 AND 1938

| Patient | Sex | Age (*Years*) | Side | Complaints | Effusion in Knee | Roentgeno-graphic Report | Date of Operation | Communi-cation with Knee Joint | Anatomy of Cyst | End Results |
|---|---|---|---|---|---|---|---|---|---|---|
| E. F. | Male | 32 | Left | Knee and cyst | | | February 1926 | Yes | Medial: Semimembranosus<br>Lateral: Inner head of gastrocnemius | |
| D. D. | Male | 10 | Left | Cyst | | | September 1926 | Yes | Medial: Inner head of gastrocnemius<br>Lateral: Outer head of gastrocnemius | |
| I. V. | Male | 45 | Right | Knee and cyst | | | September 1929 | Yes | Medial:<br>Lateral: Inner head of gastrocnemius | |
| D. K. | Male | 4 | Right | Cyst | | | February 1930 | ? | Medial: Semimembranosus<br>Lateral: Inner head of gastrocnemius | |
| A. S. | Female | 14 | Left | Cyst | | | March 1930 | ? | Medial: Semimembranosus<br>Lateral: Inner head of gastrocnemius | |
| R. B. | Female | 65 | Right | Knee and cyst | | Osteo-arthritis | January 1931 | No | Medial: Semimembranosus<br>Lateral: Inner head of gastrocnemius | No recurrence. No complaints. |
| E. S. | Male | 33 | Right | Cyst | | | January 1933 | | | |
| L. C. | Male | 6 | Right | Cyst | | | June 1933 | | | No recurrence. Some aching in knee. |
| I. A. | Male | 39 | Left | Knee and cyst | Present | Osteo-arthritis | July 1934 | Yes | Medial: Semitendinosus<br>Lateral: Inner head of gastrocnemius | |
| Same Patient | | | Right | Knee and cyst | Present | Osteo-arthritis | January 1935 | Yes | Medial:<br>Lateral: Inner head of gastrocnemius | |

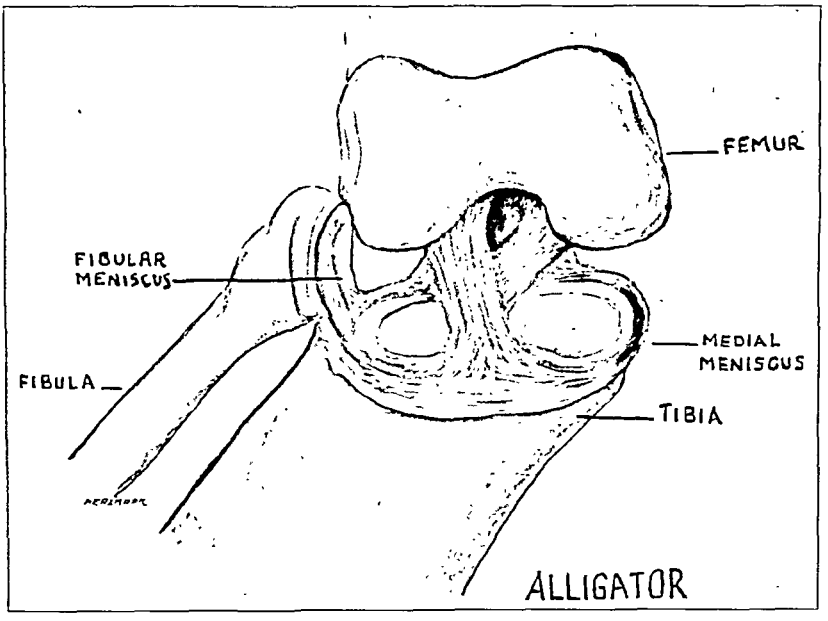



FIG. 3

its lateral border and is at right angles to it, so as to be interposed between the fibula and the lateral surface of the femur with which it articulates. A thin synovial membrane could be made out, but no patella.

The mammals have come a long way since their remote ancestors crawled about the slimy banks of their primeval swamps. One of the best examples of the simpler mammals is the *opossum*. This animal is a marsupial, has well-developed limbs, and can move quite rapidly. The knee joint shows the femoral condyles with a marked groove between them. The tibia has a sloping surface which extends anteriorly from the joint. The ligamentous termination of the extensor muscles of the thigh has a ligament which branches off at right angles to it to insert into the upper border of the sloping surface of the tibia, while the overlying tendon inserts into the lower border of the oblique surface of the tibia. There is no patella, but the extensor tendon is thickened over the joint line to form a rudimentary patella. There are two very well-developed

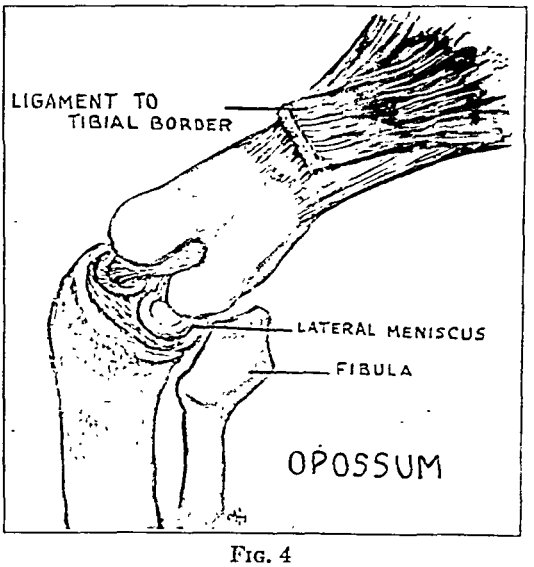



FIG. 4

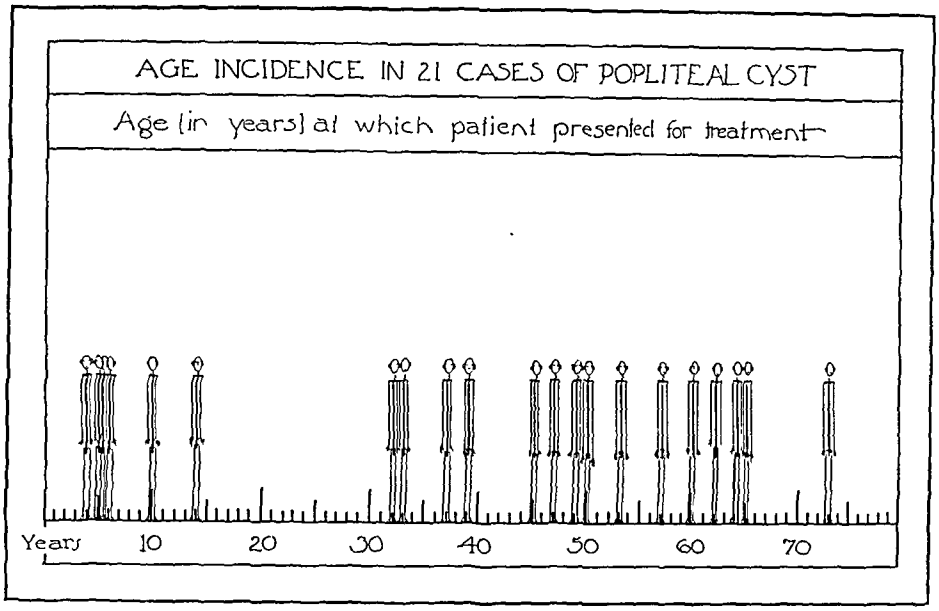



FIG. 7

Age incidence in twenty-one cases of popliteal cyst.

The age incidence is shown in Figure 7. Twenty-nine per cent. of the patients were in the first fifteen years of life; in the next fifteen years there was no case; and subsequently each decade provided an equal quota until the seventies were reached. A study of the sex incidence in this series showed that the male predominated in the ratio of two to one. There was no marked preference for either knee, and the condition was bilateral in only one case, that of a man with severe osteo-arthritis of the knee. In the children's group, the only symptom seemed to be the swelling itself with an occasional complaint of some apparent weakness or sparing of the affected limb. In none of these cases, apart from the discovery of the cyst itself, was there any positive clinical finding in con-

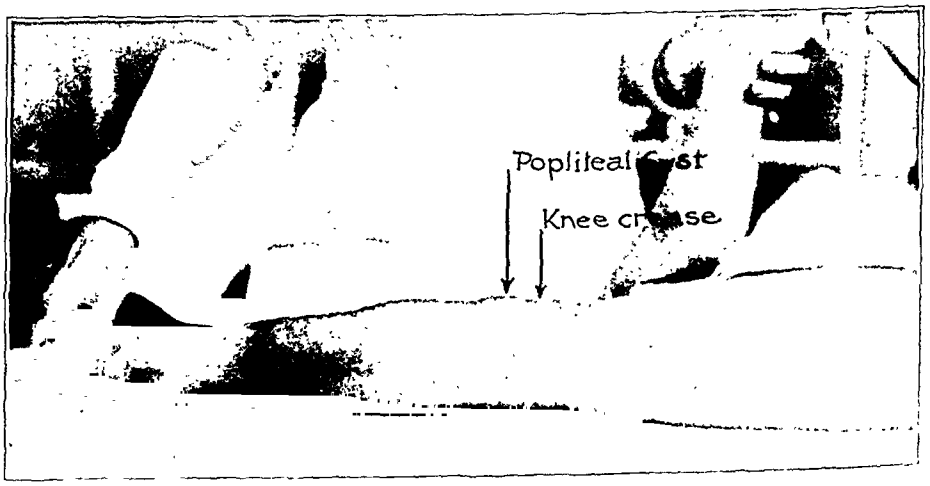



FIG. 8

Clinical photograph showing popliteal cyst lying just distal to posterior knee crease.



FIG. 9-A

Case R. P. Roentgenogram (lateral view) of right knee showing pneumarthrosis resulting from aspiration and air injection of communicating popliteal cyst.



FIG. 9-B

Case R. P. Anteroposterior view of right knee.

nection with the joint. In the adult group, the symptoms were referred to the posterior aspect of the knee and the popliteal fossa in two cases and to the whole knee in thirteen cases. In no case had the patient noticed the cyst longer than two years. In regard to the physical signs, the ease with which the cyst could be recognized varied tremendously. In some cases, on extending the knee, it was readily evident as a firm cystic swelling emerging between the muscles on the posteromedial surface, while in others it formed a lax cystic mass presenting so indefinitely as to be almost imperceptible in the fatty substance of the popliteal fossa.

In our last three cases we adopted a technique of aspirating the cyst and injecting it with air, holding the knee in slight flexion. The communication with the knee joint was demonstrated in two of the cases when a pneumarthrosis was shown in the roentgenograms (Figs. 9-A and 9-B). In the third case, that of a child, although the cyst was filled with air and a communication with the joint was demonstrated at operation, the air did not enter the joint. Cravener injected air directly into the knee, but this procedure seems to us less likely to demonstrate a communication when the opening is small. In the adult cases in which there was a notation in the histories as to whether or not the knee showed an effusion, it was present in five out of ten knees, one case being bilateral. The roentgenographic examination showed definite evidence of osteo-arthritis in seven out of eleven adult knees in which such examination was recorded, one case presenting the picture of a Charcot's knee. In only three cases

did we note the relation of the cyst to the popliteal skin crease, and in these it was slightly distal to the skin crease, a point brought out by Haggart. (See Figure 8.)

## OPERATIVE FINDINGS

In describing the operative findings, we will first give a résumé of the operative notes concerning the patients in this series, many of whom were operated upon before we began our study of this condition. We will later describe in detail our own operative findings which have been uniform in all of the seven knees operated upon by us personally. A definite communication between the cyst and the knee joint was found in fifteen knees; in two there was no communication found; and in five there remained a doubt or there was no record on this point. The cyst appeared between the inner head of the gastrocnemius and the semimembranosus in thirteen knees; in one, it was described as "originating from the semimembranosus bursa"; in two, as appearing from the inner aspect of the popliteal space; in one, from the region of the medial condyle; and in another, from between the two heads of the gastrocnemius. In four cases, the record was too vague to be of value.

In our own operations, which, unless contra-indicated were performed with the aid of a tourniquet, a curved incision, about six inches long and convex medially, was made centering over the cyst. The curved incision has the advantage of avoiding a straight scar at the back of the knee, which is often slow in healing and tends to keloid formation. The skin and subcutaneous fascia were dissected back, and the deep fascia was exposed. This was divided longitudinally, and immediately the tense cyst, which was flattened beneath the unyielding fascia, came into view. (See Figure 10-A.) It was sometimes covered with a variable amount of fatty areolar tissue. By sharp dissection, a plane of cleavage was found, and the cyst was freed until it was clearly seen to pass between the inner head of the gastrocnemius and the still fleshy belly of the semimembranosus. The tendon of the semitendinosus, passing superficial to the semimembranosus, lay in medial relationship to the cyst. The cyst wall was next dissected away from its attachment to the semimembranosus and the inner head of the gastrocnemius. There was no plane of cleavage here, and it was necessary to resect a portion of the tendinous covering of the gastrocnemius muscle and a thin superficial layer of the semimembranosus along with the cyst wall if rupture was to be avoided. (See Figure 10-B.) The cyst was found to be compressed between the two muscles when the knee was extended, so that moderate flexion of the knee rendered this part of the dissection easier.

The cyst was then opened and inspected from inside, and it was found to be adherent to the deep surface of the inner head of the gastrocnemius, passing laterally to at least half its width. (See Figure 10-C.) From here it was reflected onto the posterior capsule to which it was equally adherent over an area sometimes as much as two inches square.

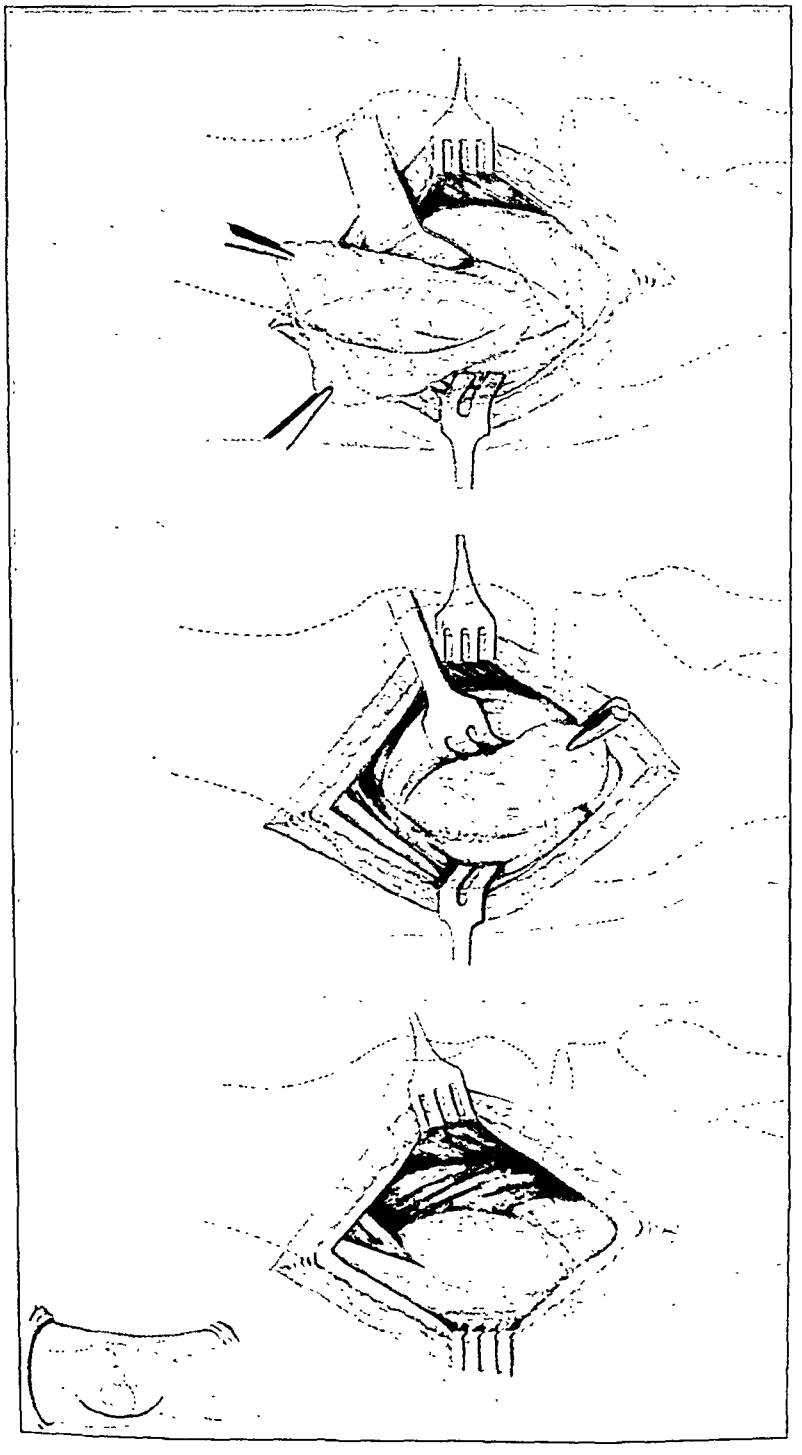


FIG. 10-A FIG. 10-B FIG. 10-C

*Typical operative findings:*

FIG. 10-A: Exposure after incision of deep fascia.
FIG. 10-B: Separation of adherent cyst from semimembranosus and inner head of gastrocnemius.
FIG. 10-C: Cyst turned up and incised. Interior shows communication with knee joint and intimate contact of deep portion of cyst with capsule, tendon of semimembranosus, and deep surface of inner head of gastrocnemius.



FIG. 11

Photomicrograph (×100) showing inner lining of popliteal cyst composed of loose fibrous tissue. There is a surface layer of mesothelium. The hyaline material lies on the surface and has been traced to degenerated cartilage.

The deeper part of the cyst, intimately blended to these tendons and the capsule, usually appeared small in comparison with the remainder of the cyst and might be described as the neck of the cyst. When the cyst was smaller, this fixed deeper portion was found to form a relatively larger portion of the cyst. The communication with the joint was found

proximally under the inner head of the gastrocnemius and close to the origin of this muscle. In relation to the joint, the opening lay near the upper part of the posterior articular surface of the medial condyle of the femur. It might be covered by a membranous fold. In one child we found a definite septum, suggesting the origin of the cyst from the two primary bursae. The communication was always found to be smaller than that seen in our anatomical dissections.

The anatomy of the deeper part having thus been closely studied from within, the removal was completed by dissecting the cyst from those structures to which it was adherent. The inner head of the gastrocnemius, retracted strongly laterally, acts as a useful barrier between the field of operation and the important neurovascular structures placed more centrally in the popliteal fossa. The perforation in the capsule through which the cyst communicated with the knee joint was sutured when this could be accomplished with ease. This was not always the case, as the capsule was frequently taut and the edges could not be approximated. In this series, closure was effected in eight out of the fifteen cases in which a communication existed. The tourniquet was then removed and hemostasis obtained. The deep fascia was sutured, followed by closure of the subcutaneous layer and the skin. A compression bandage over an adequate layer of rolled sheet cotton completed the dressing, no splint being used.

The postoperative treatment consisted of rest with the leg elevated for the first three days. The compression bandage was released after twenty-four hours, unless this had been done previously on account of discomfort. Elderly patients were encouraged to sit up in bed and to engage in minor activities to avoid hypostasis, and many were allowed up in wheelchairs as early as the second day. Setting exercises of the quadriceps were started on the fourth day and continued until full function of the knee and of the quadriceps muscle had been restored. Sutures were removed on the tenth day when the patient was allowed up, wearing an ace bandage. The patient was usually discharged about the twelfth day. Complications consisted of moderate postoperative effusion in two cases, in neither of them sufficient to cause discomfort, and the breaking down of a keloid scar three months after operation in one case, later requiring excision and resuture.

## PATHOLOGY

Through the cooperation of Dr. D. A. DeSanto, Pathologist of the Hospital for the Ruptured and Crippled, detailed pathological studies of specimens obtained from eighteen knees were made. On gross examination, the cyst wall varied in thickness from one-fourth to one-thirty-second of an inch; the fluid within was viscid, and frequently contained fibrin. The inner lining was generally smooth, but in areas might be slightly roughened, due to adherent hyaline material. The outer surface was usually irregular and showed adherent fibro-fatty and areolar tissue. Sections showed a fibrous wall lined with flattened mesothelium (Fig. 11). The wall was for the most part flat, but was sometimes



FIG. 12

Photomicrograph (×100) showing a portion of a wall of a popliteal cyst with areas of hyaline and fibrocartilage.

arranged in vascular papillary folds resembling synovia. In places the lining surface was covered with an adherent hyaline exudate. The connective tissue was for the most part highly cellular in character, showing numerous proliferating fibroblasts and areas of lymphocytic infiltration. The outer portions of the cyst wall consisted of fibro-fatty tissue and

contained medium-sized blood vessels. In the majority of the adult cases metaplasia into hyaline cartilage and fibrocartilage was observed in certain areas of the cyst wall (Fig. 12). In two cases (one of which was the case of Charcot's arthropathy), osteoid tissue and bone were found. In one case, in a child, primitive cartilage cells were present in the wall of the cyst. At least one-quarter of the cases showed clumps of intracellular hemosiderin pigment.

## END RESULTS

We have been able to obtain end-result examinations in only eight cases; the remainder of the patients either have been operated upon within the last three months or have not been located. One patient, a child of eleven years, who was operated upon five years previously, complained of occasional aching in the knee after a day's exertion. Physical examination showed perfect function of the knee and it was noted that the complaint in no way interfered with games or other activities. In the patient with Charcot's arthropathy of the knee, the benefit obtained from treatment appeared to have resulted more from the use of the caliper brace than from the excision of the popliteal cyst. In another patient, a woman of sixty, who had been operated upon only six months previously, a small recurrent cyst appeared to have developed in the same situation,—namely, the medial part of the popliteal fossa. At operation the cyst, which showed moderate hyperplasia of the surface layer of its lining, was found to be typical of a distended gastrocnemio-semimembranosus bursa and communicated with the knee joint. An attempt was made to close the opening in the capsule with a silk stitch, but the approximation of the edges was unsatisfactory. The recurrence was confirmed by aspiration and injection of air, which proved that there was a small deep cyst communicating with the joint. The remaining five patients were relieved of all posterior discomfort and complained only of "rheumatic" aches proportionate to the osteo-arthritic changes present in the knee.

## DISCUSSION

Our study, based upon a review of the clinical and operative findings in twenty-one cases and anatomical dissections in thirty cadavera, has convinced us that popliteal cysts are, if not invariably, at least in the great majority of instances fluid distentions of the gastrocnemio-semimembranosus bursa. The arguments that support this view are, first, the almost invariable origin of the cyst from between the inner head of the gastrocnemius muscle on the one hand and the tendons of the semitendinosus and the semimembranosus muscles on the other, a situation which corresponds to that of the bursa. Excluding the four cases in which the operative description was inadequate, this relationship was noted in fourteen cases. In one case, the cyst was described as arising from the region of the medial condyle, which would correspond with the location of the bursa. In two others, it was stated to have originated from the inner side of the popliteal space; and in one other, from between the two heads of the

gastrocnemius muscle. We are inclined to question the accuracy of this last description, since the semimembranosus muscle has a fleshy belly extending downward to a point about two inches above its insertion, which, in the case of displacement of the inner head of the gastrocnemius laterally by a large cyst and of a limited exposure, might easily be mistaken for the gastrocnemius muscle.

The second point is the almost invariable finding at operation of an intimate attachment between the medial and the lateral walls of the deeper part of the cyst and the tendinous portions both of the gastrocnemius and of the semimembranosus muscles. So intimate is this fusion that it is necessary to resect a portion of the muscle or tendon along with the cyst wall if one is to avoid tearing it. This fact has been constantly mentioned in the operative notes and has been our invariable personal observation. Even Haggart, who supported the theory of herniation and described most of the cysts operated upon by him as originating from between the two heads of the gastrocnemius muscle, mentioned this finding. Our dissections of the gastrocnemio-semimembranosus bursa invariably revealed a similar intimate blending of the bursal walls and the adjacent surfaces of the muscles. (See Figures 13-A and 13-B.) Such an intimate attachment is characteristic of a bursal structure present from birth and destined to permit gliding action of these structures, and it is quite different from what would be expected with an adventitious hernial protrusion which would displace structures ahead of it.

The position of the opening in the posterior capsule communicating between the cyst and the knee joint, high up behind the medial condyle, also corresponds to the position of the opening between the bursal cavity and the knee joint. Such a communication is not invariably present either in the cyst or in the normal bursa. It was demonstrated in fifteen of the twenty-two cysts that were excised and was found in seventeen of the thirty anatomical specimens that were dissected. It would be easy to overlook such an opening at operation on account of its situation high up under the origin of the inner head of the gastrocnemius muscle and its attenuated margins, which blend almost imperceptibly with the small exposed portion of the articular cartilage.

The theory of origin of the cyst as a hernial protrusion must surely postulate increased intra-articular pressure, due to chronic joint effusion, as a cause, yet six of our twenty-one patients were children in whom there had never been any effusion and whose knees appeared perfectly normal except for the cysts. One would not expect a hernial protrusion of the joint capsule in a child and would consider either a congenital deviation of a normal structure or a ganglion as more likely causes. The operative findings in these cases ruled out ganglia, because of the nature of the fluid contents, the frequent communication with the joint, and the size of the tumor, and we believe they can be best explained as bursal distentions. Although gross effusion in the knee joint played a prominent part in a certain proportion of the adult patients with cysts, its complete absence in

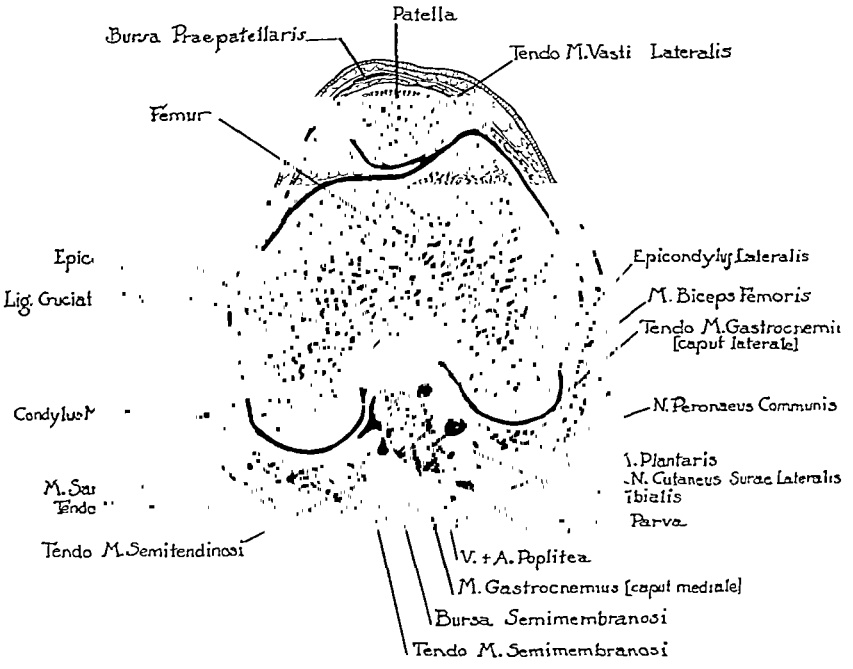



FIG. 13-A

Cross-section at level of knee, showing gastrocnemio-semimembranosus bursa.

many others precludes it from playing an essential rôle in the etiology. Should considerable effusion and intra-articular pressure play an important part in any one case, would they not act in distending a communicating bursa with its unsupported walls rather than expending themselves in producing a fresh pouch in better supported areas of the capsule?

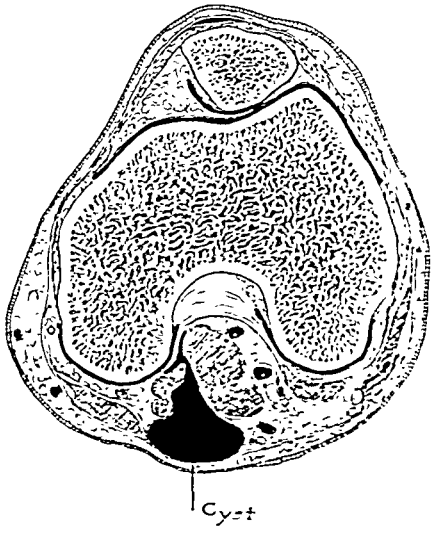



FIG. 13-B

Cross-section at level of knee, showing popliteal cyst.

An interesting question in respect to these cysts is why they remain distended with fluid in spite of a communication in most instances with the knee joint. A few of the patients did in fact notice the rather sudden disappearance of the swelling at the back of the knee and its reappearance only after considerable intervals of time. We have one patient under observation at present in whom a cyst was demonstrated by aspiration of fluid, after which the swelling disappeared and remained absent for two

years. We tried to empty some of the cysts by pressure, but without success except in one instance at operation after the cyst was freed. Yet when air was injected into the cyst it passed promptly into the knee joint. This behavior suggests a valve-like action at the mouth of the cyst. The only explanations we can suggest are that either the close application of the communication to the femoral condyle permits the latter to act as an obturator in the opening, or the close approximation of the gastrocnemius and the semimembranosus muscles compresses the deeper portion of the sac sufficiently to shut off the fluid in the more superficial part. In this connection, it should also be remembered that the fluid is often viscid and the opening itself is small.

There remains to be considered the cause of these effusions in the gastrocnemio-semimembranosus bursa. We can find no evidence to support a theory of infectious or toxic origin and are forced to conclude that they are due to trauma of the bursa, either in the form of repeated small injuries from the vigorous contraction of the muscles which in part help to form its walls or from a single violent movement which actually tears a part of the wall. The frequent finding of blood pigment in the wall of the cyst on microscopic examination lends support to this theory. The sequence of events would appear to be traumatic irritation of the bursa followed by effusion. When the bursal sac becomes even moderately distended, it is then subject to repeated irritation from movements of the knee and use of the muscles. A process of chronic inflammation is then set up, which leads to gradual thickening of the wall of the sac with metaplasia of the reparative elements into cartilage, as was so frequently found on microscopic examination of the excised specimens, and occasionally into bone. Congenital aberration in the structure of the bursa may well play a part in the process, particularly in the case of children.

Finally, we would suggest that the various bursae at the posterior aspect of the knee, and particularly the large gastrocnemio-semimembranosus bursa, are probably of greater clinical importance than has yet been realized. Inflammation in these bursae may offer an explanation of many complaints of vague pain at the back of the knee. Confirmation of such a diagnosis may readily be obtained by aspiration, especially of the gastrocnemio-semimembranosus bursa, which can be easily located. The latter bursa, which so often communicates with the knee joint, must be frequently involved in septic arthritis of the knee and also in tuberculosis and may offer an easy pathway for extension of the infection into the popliteal space. It should be investigated either by palpation or by aspiration in all such cases.

There remains the question of treatment of a popliteal cyst. Should it be removed? It is in all cases likely to give rise to symptoms *per se*, and in most instances it is prone to cause irritation of the knee through extension of the inflammatory process along the lining membrane and the slow discharge into the knee of the somewhat irritating fluid in the cyst. While aspiration may yield temporary relief, we believe that permanent

relief can be obtained only by excision of the cyst. The operation is unlikely to cause any serious complication, and we believe that it is indicated in almost all cases. Recurrence of the cyst after thorough excision is rare.

## SUMMARY AND CONCLUSIONS

1. The large gastrocnemio-semimembranosus bursa appeared in twenty-six out of thirty dissections. In four, we found two bursae,—one under the inner head of the gastrocnemius, and one between this muscle and the semimembranosus.

2. The composite gastrocnemio-semimembranosus bursa communicated with the knee joint in fifteen out of these twenty-six dissections; the bursa under the inner head of the gastrocnemius communicated with the joint in two out of the four cases in which there were two separate bursae; while the bursa between the inner head of the gastrocnemius and the semimembranosus was never found to communicate directly with the joint.

3. Thirteen out of fourteen cysts in the medial portion of the popliteal space, the anatomy of which was recorded in detail in the operative notes, appeared between the semimembranosus tendon and the inner head of the gastrocnemius.

4. The cysts were adherent to part of the tendinous surfaces of these two muscles in a manner similar to that found in the semimembranosus bursa.

5. Cysts were found in children and in adults and appeared similar in the two groups.

6. An effusion in the knee joint was present in only five out of ten cases in which this point was referred to in the preoperative note.

7. Our studies lead us to conclude that most, if not all, popliteal cysts are the result of fluid distention of the gastrocnemio-semimembranosus bursa.

8. We believe that the cysts result from injury to the bursal wall caused by muscle contractions followed by effusion.

9. Microscopic examination of the cyst walls showed blood pigment frequently present, also fibrous thickening and cartilaginous and osteoid metaplasia.

10. Operative excision of the cyst appears to be the best treatment.

11. The various bursae at the back of the knee, and particularly the large gastrocnemio-semimembranosus bursa, would seem to have greater clinical importance than has yet been realized.

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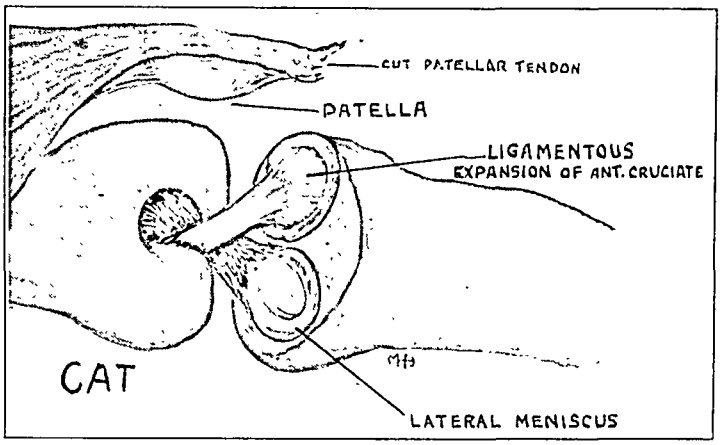



FIG. 5

semilunar cartilages. The lateral meniscus has a prolongation posteriorly which corresponds to the posterior cruciate ligament. The ligamentum mucosum is well developed and inserts into the tibia between the two menisci. The head of the fibula is enlarged and extends above the joint line to the lateral condyle of the femur, but no intra-articular cartilage is seen as in the alligator.

The line of ascent now brings us to the placentalia, of which an excellent example is the *cat*. The limbs are muscular, and the joints are designed for efficient function under strenuous conditions. A well-developed patella is observed with its patellar tendon inserted into the tibia well below the joint line. A ligamentous band runs off beneath this tendon to attach to the transverse ligament. The condyles are well developed and a deep groove lies between them, which always indicates speedy locomotion. The medial meniscus is a narrow band of fibrocartilage, formed by a thickening of the coronary ligament, and is attached at the medial border to the expansion of the anterior cruciate ligament. This expansion of the anterior cruciate ligament spreads out as a thin membrane to cover the entire medial tuberosity, disappearing under the free edge of the medial meniscus. The posterior cruciate ligament inserts by two branches into the posterior edge of the tibia, but does not spread over the cartilaginous surface of the lateral tuberosity. The head of the fibula is small and articulates with the tibia only.

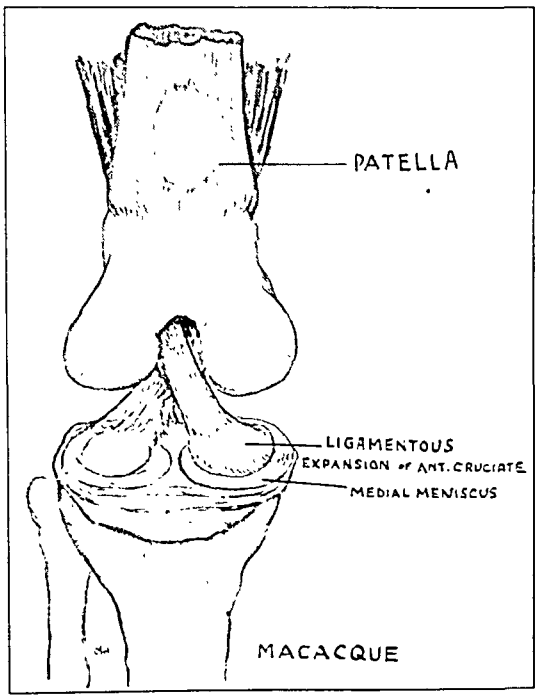



FIG. 6

The highest development in the animal kingdom is attained by the primates. These are the monkeys whose limbs are well adapted to strenuous running, climbing, jumping, and swinging.

As an example of the more primitive of this group, the knee of a *macaque* was studied. This

# GAS-BACILLUS INFECTION AS A COMPLICATION OF FRACTURES

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## HISTORY

The results of infection with bacillus welchii and associated organisms were probably first reported by Hippocrates. A massive amount of investigation and work has been done on the subject since that time. In 1749, Quesnay described the subcutaneous emphysema, and Velpeau, in 1839, noted its frequent occurrence in compound fractures. De Bazas, in 1836, analyzed the gas found in the tissues, noted its inflammability, and demonstrated the presence of hydrogen sulphide as the most prominent component. Maisonneuve is probably the most quoted early worker along these lines. In 1853, he gave the condition the name of "*gangrène foudroyante*". While many writers reported innumerable cases of gas-infected wounds during the major European wars, Keen, during the American Civil War, recorded not a single case. Welch isolated the organism bearing his name; Pasteur, the vibrion septique; and Koch and Novy, the bacillus oedematiens. It has been reported that 2 per cent. of all wounds sustained by the American Expeditionary Force were infected with gas and that 48.52 per cent. of these patients died. In view of all recent reports, this stands out as one of the major tragedies of the World War, for, in 1930, Larson and Pulford reported seven cases, in all of which the gas infection was controlled with serum which they used unrefined and in amounts up to 1000 cubic centimeters. One of the patients died, but many days after the control of the gas bacillus and from streptococcic infection. The most noteworthy fact was that *amputations were not done.* Apparently this report has been overlooked or its importance has been minimized, for the mortality of two other reported series in 1935 and 1936, treated with serum plus amputation, has remained about 15 per cent. Then, in 1936, Kelly and Dowell reported a series of cases, all of which were treated by x-ray therapy and all except seven with serum. In this series, 45 per cent. of the patients who also had amputations died, while none of the patients who had no amputations died.

## BACTERIOLOGY

One of the most rational reports on the bacteriology of these infections and the establishment of diagnosis was made by Reeves. He pointed out that of the seven spore-forming anaerobes pathological for man, clostridium welchii was found in 79 per cent. of the cases of gas-infected war wounds, and in 14 per cent. it was the only organism. Vibrion septique was also frequently present, but clostridium oedema-

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early, little if any discoloration will be noted. The wound will be drier than usual and the underlying tissues will have a doughy consistency, tending to bulge through the skin opening. Roentgenographic examination will show gas in the soft structures, but to be positive must show an increase in the amount of gas over an interval of time. Compound fractures or operations frequently permit a certain amount of subcutaneous emphysema and roentgenograms under these circumstances will show the same or a diminished amount of gas. A smear from the wound, anaerobic inoculation, animal-liver injection and incubation, capsule stain, and the beginning of cultural identification should be immediately undertaken.

## TREATMENT

There is no question that prophylaxis in the form of tetanus *and gas* antiserum should be used in every case of compound fracture. The reason that our series is no larger, covering as it has Fracture Services in seven hospitals, is undoubtedly due to the fact that this rule has been uniformly established. One patient with a compound fracture failed to get gas serum but did get tetanus antiserum and within fourteen hours a severe gas-bacillus infection of the wound developed. Curative serum therapy should be commenced with clinical diagnosis, for bacteriological confirmation will take time and the loss of even three or four hours is important. We have used twenty-cubic-centimeter doses of refined polyvalent serum intravenously every two hours until the gas infection was under control. Since no statistics are available and this dosage seemed adequate, we have established this as a standard for ourselves. No intramuscular serum has been used. In operative cases drainage through the original operative wound is usually sufficient, but if only a compound wound is present, it should be enlarged through the skin and fascial planes with due regard for vessels and nerves. Débridement or removal of masses of muscle should be avoided. Intramuscular planes should be opened in areas of greatest infection if possible, but unnecessary destructive surgery should not be done. Muscle which appears to be dead, if let alone, will frequently be found viable at a later date. Transfusions are necessary, especially in those cases complicated by clostridium histolyticum. In our series, continued or repeated massive infusions of glucose and saline were routinely used. Support of the part in metal splints with continuous moist dressings to encourage drainage is important. The kind of fluid used for irrigation or moistening of dressings is relatively unimportant. It is evident that peroxide, potassium permanganate, etc., cannot reach all infected areas. Amputation is senseless and harmful, and all reports to date will bear this out. We have an agency which will destroy the infection where it lies,—namely, serum. X-ray therapy can be questioned from many angles, but the fact remains that seven patients in one series, without serum or amputation or any known specific medication, all recovered with x-ray therapy and that none in that same series, treated by x-ray alone, died. One can argue that bacteriological reports

tiens, clostridium histolyticum, and clostridium fallax were rare. Although they are rare, Ghormley stresses the need of investigating cases of infection similar to gas infection having oedema only. He had one fatality, with clostridium oedematiens as the only organism. In retrospect, the author feels sure that he missed one similar case in which the patient died. Reeves also discounts inoculation of rabbit and guinea-pig liver with destruction of the animal and incubation of the body for the presence of gas and organisms in the liver as a rapid means of identification of these bacteria. He holds that capsule-stain tests for bacillus welchii or cultural methods for the other organisms must be done to establish definitely their presence. It is almost universally conceded that the presence of gas in cases of amputation done in old people for arteriosclerosis or diabetes is due not to bacillus welchii and associated organisms, but to other organisms always present in aged or devitalized living tissue prior to amputation.

## PATHOLOGY

The differentiation between true gas-bacillus infection and the gas infections of amputation stumps in old or diabetic patients is further confirmation of the pathological changes found. In the former, no line of demarcation is present and the infection spreads rapidly and without limitation in muscles and under fascial planes; whereas in the latter, a true line of demarcation always forms if a terminal event does not occur. Liver change is a common finding in late cases associated with jaundice. The swelling of involved muscle tissue and liquefaction with gas production have been frequently described. It is noteworthy that discolored, dark, distended, or even partially liquefied muscles are not always dead.

## DIAGNOSIS

While the odor cannot be relied upon, since it is inconstantly present, still these patients present a peculiar clinical picture which if once seen is likely to be recalled. One should always be in a suspicious frame of mind when dealing with fractures which are compound or have been compound at any time and in which repair is taking place. The fact that the wounds are healed is no guarantee that a massive bone graft or even the removal of metallic fixation may not stir up a latent infection dormant in the tissues. In each case the most outstanding impression has been of a very sick patient, slightly disoriented, complaining of great pain if asked, but otherwise lying quietly with a flushed face, very rapid pulse, and no great temperature. The patient is evidently sick and toxic way beyond the bounds indicated by temperature alone. Many years ago such a case was seen under the care of another physician and went to fatal termination before proper diagnosis was made. The clinical picture of that case so impressed us that in all subsequent cases we have readily made a correct clinical diagnosis. Percussion of the skin anywhere near the wound area will give a tympanites and palpation crepitus. If the patient is seen

## CONCLUSIONS

1. Prophylaxis with both gas and tetanus antiserum should be the rule in all cases of compound fracture.

2. Amputation should never be done for acute gas-bacillus infection, although it may later be necessary because of deformity.

3. Repeated massive doses of intravenous polyvalent serum should be continued until the gas-bacillus infection is controlled.

4. Drainage but not débridement should be instituted. Many tissues first thought to be dead will later be found viable.

5. X-ray therapy may yet prove to be of the greatest help.

6. Orr dressings and treatment may be safely carried out as in any other infection of bone, once the acute gas infection has been brought under control, without regard to the presence of bacillus welchii and its associates which remain lying apparently inert in the wound.

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on these cases are lacking, but it is impossible to conceive that in all of them there was failure of proper diagnosis. Most, if not all, must have been cases of true gas-bacillus infection. Until further work has been done along these lines, the writer would not advise reliance on x-ray therapy alone, but he does feel that it should be used as an adjuvant to serum therapy.

## CASE REPORTS

CASE 1. I. S. An operation for removal of a Parham band and graft of the humerus was done on January 6, 1937. Granulation tissue found around the Parham band was not cultured. Severe gas-bacillus infection, involving the arm, the upper forearm, and the chest wall, was discovered in thirty-six hours. The patient had pneumonia, not proved to be due to bacillus welchii. The presence of bacillus welchii was proved by cultures taken from the wound. The operative wound only was opened, and twenty cubic centimeters of refined polyvalent serum was given intravenously every two hours after desensitization. A total of 400 cubic centimeters, or 400,000 units, was given with 1000 cubic centimeters of blood and 6500 cubic centimeters of glucose intravenously within thirty-six hours, at which time the infection was entirely under control, the temperature was down, and the patient was rational. Severe serum sickness developed in seven days. A cast and Orr dressings were applied at the end of three weeks, with bacillus welchii present by culture in the wound and without any reaction whatever. Under successive Orr dressings the wound healed and the graft was sequestrated as in any osteomyelitic case. Biopsy and removal of the scar of the healed wound fourteen months later showed bacillus welchii still present in the deep tissue, although the scar was soft, pliable, and freely movable on the underlying tissues.

CASE 2. A. B. On October 1, 1936, the patient suffered the following injuries: on the left—fractures of the femur, the middle third of the radius, the lower third of the radius (Colles), the carpal navicular, the ankle (Potts), the tarsals with dislocation, and a compound fracture of the middle third of the tibia; on the right—fractures of the clavicle and the scapula, fracture of the pelvis with separation of the symphysis pubis; and rupture of the urethra. A protective dose of bacillus welchii serum was given on admission, but five days later a mild bacillus welchii infection, culturally proved, developed in the wound which had been left open. This infection was easily controlled with four intravenous administrations of twenty cubic centimeters of serum, 80,000 units in all. The patient's reaction to the gas infection was mild and, therefore, difficult to determine clinically when the case was under control. Twenty four days after fracture, Orr dressings and casts were applied without any reaction referable to the gas bacillus probably still present in the wound. The compound lesion healed uneventfully; all of the other fractures united; and the patient is without disability except for deformity due to the fracture-dislocation of the left foot.

CASE 3. R. J. By error, gas-bacillus serum was not given on this patient's admission on January 18, 1937, for a compound fracture of the right tibia. Within fourteen hours he had a moderately severe gas-bacillus infection of the entire right leg, proved by cultural methods. The skin of the calf was split longitudinally on the inner and outer sides, and moist dressings were applied. He received 110,000 units of polyvalent bacillus welchii serum intravenously within thirty hours, with two transfusions of 500 cubic centimeters each. By that time, without other treatment, the gas-bacillus infection was entirely controlled. A moderate serum sickness developed a week later. Sixteen days after injury, casts and Orr dressings were applied without any reaction from the bacillus welchii still present, and healing and solid union took place as in any other compound fracture similarly treated. Bacillus welchii was proved by culture to be still present in the wound four weeks following the application of the first closed dressing and cast. There was no clinical evidence of gas infection in the tissues at that time.

application to low-back conditions cannot be regarded as new. Up to the present, however, it has been consigned to the outer regions of therapy and regarded as unorthodox. Because of its nature, its use is restricted to a particular group of low-back conditions. In its employment, therefore, the differential diagnosis of low-back conditions becomes of the utmost importance. An accurate history of the patient—including a detailed family account, habits, environmental and occupational influences, and, most important, a regional survey with cardiac, respiratory, gastro-intestinal, and genito-urinary investigations—will supply information which will immediately exclude many possibilities of a symptomatic nature. The physical examination should include a detailed examination of the back. Roentgenograms should be taken to verify the examiner's impressions or conclusions. All frank pathological lesions of the back will have been excluded.

We are, therefore, concerning ourselves not so much with those conditions of the low back which are made obvious from the history or whose true nature is immediately disclosed by roentgenograms, but, rather, with those conditions of low-back pain whose pathological background is indifferent or indeterminate so far as a correct allocation of the cause of the pain is concerned. Such conditions include the anatomical variations (sacralization, impinging transverse processes, etc.), congenital anomalies, poor posture (contraction of the tensor fasciae latae, marked lordosis, etc.), dislocations (apophyseal subluxation, spondylolisthesis, etc.), fasciitis and myofascial syndromes, and sprains (acute or chronic) of traumatic etiology. It is the author's opinion that in all of the foregoing conditions, the element of sprain plays an important rôle,—whether it has been the result either of a direct traumatic incident or, because of impaired body mechanics, of a kind of trauma active over an extended period of time.

Searching analyses of these conditions from different points of view have been appearing from time to time. Kendall, of Baltimore, has contended that imbalanced foot muscles may inaugurate the low-back syndrome, the pronated foot and internally rotated femur giving rise to secondary contraction of the internal rotator muscles of the hip (including the tensor fasciae latae) and of the sacrospinalis muscles.

Reasoning somewhat in the reverse direction, Ober considers the contracted tensor fasciae latae as the precipitating or primary factor in the syndrome rather than one of the resultant conditions. While these two observers have approached the facts along different avenues of thought, nevertheless both observations are of value in the treatment of low-back conditions and will be considered in more detail in the following pages.

Pitkin and Pheasant, in a series of five articles, have analyzed the various aspects of low-back pain with scoliosis or list and sciatic irritation under the caption "sacrarthrogenetic telalgia". Their conclusions are stimulating and some are as follows:

# BACKACHE

## A Manipulative Treatment without Anaesthesia * †

BY FREDERICK A. JOSTES, M.D., F.A.C.S., ST. LOUIS, MISSOURI

*From the Department of Surgery, Washington University School of Medicine*

In the course of the development of a particular medical thought, when the literature promises to become voluminous, one sometimes suspects that the particular thought is not so clear. In a rather paradoxical manner, the more numerous and detailed the studies become, the less of actual fact do we ferret out. The literature on the subject of low-back pain, voluminous in the past, lately has been given added impetus. One feels, however, that, unlike many other problems, the growing literature on this problem is not indicative of how little is known on the subject, but how rapidly its various ramifications are becoming increasingly clarified.

There are perhaps few other symptoms in medicine which, because of the multiplicity of the etiological possibilities, offer a greater problem so far as differential diagnosis is concerned. A consolidated area of lung tissue becomes manifest through inspection, palpation, percussion, and auscultation. Here we appreciate the symptom of pain and understand its causation. On the other hand, when the patient complains of pain for which there is apparently no immediate clear-cut background of disturbed anatomy, we are left with a problem of pathological physiology whose source may be near or remote and which, at the exodus of the patient, with all other active physiological manifestations disappears from the inquirer's search.

Low-back pain is becoming more clearly recognized as a subject of multiple aspects, arising from multiple causes, and it is, therefore, a more intriguing therapeutic problem because of the many facets which it presents. Methods of treatment have been multiplied and diversified. At the present time, we are at least equipped to attack the problem on a number of fronts: on the anatomical side, from anomalies and discrepancies of bone relationship; on the static physiological side, from the standpoint of poor body mechanics; on the kinetic side, from the aspect of trauma and sprain of the muscles and ligaments and of joint subluxation; from the general pathological aspects of suppurative arthritis, tuberculosis, malignancy, etc.; and from the neuropathological aspects of cord pressure from prolapsed discs, tumors, and hypertrophied elements.

The form of treatment which the author proposes to discuss in its

* Read at the Annual Meeting of the American Academy of Orthopaedic Surgeons, Los Angeles, California, January 19, 1938.

† This communication, when originally presented, was illustrated with a 700-foot motion-picture film demonstrating the manipulative procedures. This film is available upon request.

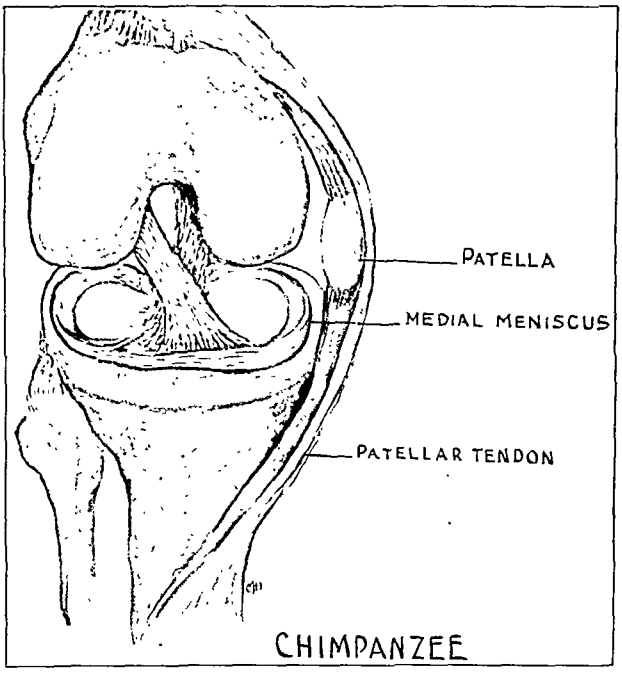



FIG. 7

animal has no prehensile tail, but its legs have an opposable hallux which makes the foot a grasping organ. The knee joint is well developed. The patella and patellar tendon are closely bound over the joint, allowing very slight excursion of the bone. The medial meniscus arises from the coronary ligament and extends only as a narrow circular rim around the tibial tuberosity. The anterior cruciate ligament is quite large and as it reaches the tibia it expands into a ligamentous membrane, covering over the entire medial articular surface of the tibia and disappearing under the free edge of the meniscus. The posterior cruciate ligament becomes attached to the lateral meniscus which is also very narrow and circular. The cruciate ligaments would seem to provide extra stability to the joint when greatly flexed, as well as when extended under traction as when the animal swings from a branch. The narrow menisci would appear to allow for rotation with little danger of tearing the interior thinned-out portion, as found in the human knee.

The simians are the most highly developed of the primates and the remarkable resemblance of the body structure to that of the human being is well known. The knee of a *chimpanzee* was dissected and studied with reference to the habits of the animal. This monkey assumes a partly erect posture, but helps to support its body with the forelimbs, using the backs of the phalanges for this purpose. The knee joint is held in a habitually flexed attitude, and the muscles are very well developed, the muscle tissue extending well down to the joint line. On dissecting the joint, it is seen that the rather small patella is tightly bound down over the joint by a strong patellar tendon. This allows for very slight excursion of the patella. The condyles are well developed, and the groove between them is much less pronounced than in the macaque. The cruciate ligaments are unusually large in proportion to the joint, but they do not expand over the articular surface as in the cat or the macaque. The menisci are crescentic and are more nearly like that of the human being but very narrow. The closely knit construction of the joint makes it

CHART I

ROUTINE EXAMINATION CHART

Name: Address:
Occupation: Age: Referred by:
Chief Complaint: Duration: Onset: Attacks:

*Physical Examination:*

I. Inspection:

Standing posture:

A. Posterior view: List: Homolateral Contralateral Alternating
Scoliosis: Thoracic Shoulders: right
Lumbar Sacrospinalis left
Gluteal crease: Relaxation Atrophy
Position of posterior superior spine

B. Lateral view: Chest { flat / elevated } Back { round / straight }
Lordosis Abdomen

C. Anterior view: Shoulder girdle rotated to Pelvis rotated to
*Position of anterior superior spine* *Rotation of femora*
Pronated feet

Leg Measurements:

| | | | | | | |
|---|---|---|---|---|---|---|
| Actual (anterior superior spine to internal malleolus) | right | left | Apparent (umbilicus to internal malleolus) | right | left |
| Calf | right | left | Thigh | right | left |

II. Palpation:

Palpable tenderness:

| | | | | | |
|---|---|---|---|---|---|
| Iliolumbar: | right | left | Lumbosacral: | right | left |
| Sacro-iliac: | right | left | Sacrotuberous: | right | left |
| Piriformis: | right | left | Sciatic nerve: | right | left |
| Sacro-ischial: | right | left | Interspinous ligaments: | right | left |
| Vertebral spines: | right | left | | | |

III. Active Movements:

Standing:
Forward flexion: Lateral left Lateral right
Hyperextension: Rotary left Rotary right
Sitting:
Forward flexion:
Supine:
Straight-leg raising right left

IV. Passive Movements (Special Tests):

Pressure on iliac crests and symphysis pubis:
LaGuere's Gaenslen's Ely's right left
Ober's abduction right left

V. Neurological:
Knee jerks Ankle jerks Babinski Saddle anaesthesia

VI. Significant Laboratory Work:

VII. X-Ray:

VIII. General Remarks:

"Pathological changes in the tension of, or irritative stimuli applied to, the extra-articular ligaments of the upper sacral joints cause telalgia in the lower extremities."

"Sacro-iliac mobility can be demonstrated *in vivo* by measuring the movements of the ilia."

"Abnormal sacro-iliac mobility is a potent cause of the abnormal ligamentous tension that produces sacrarthrogenetic telalgia."

In a more recent communication, Steindler, describing the posterior-division syndrome, has shown by means of his procaine hydrochloride test that "both local pain and radiation are in causal connection and that radiation may be elicited by an area of local pain as a reflex symptom without being caused by root compression".

## PHYSICAL EXAMINATION

The physical examination is carried out on the premise that the low-back pain in question is the result of sprain or injury to the ligamentous apparatus, including the secondary reactions of the musculature and nerve irritation. The standing posture of the patient is observed in its various aspects. There may be either no list or a very slight one, or the patient may be locked in a position of flexion deformity by severe muscle spasm. Under palpation, an attempt is made to localize exactly the site of pain and of tenderness. Whether one is prone to think of low-back pain in the horizontal terms of lumbosacral and sacro-iliac strain, or in the vertical terms of anterior-division and posterior-division syndromes, the Smith-Petersen routine of back examination is of considerable value in further localizing the disability. The various tests—including straight-leg raising, Gaenslen's, Ober's abduction test, Ely's test, etc.—are also routinely employed. The form which the author has found useful in recording the data obtained at examination is shown as Chart I.

## TREATMENT

Sprains involving joints vary in severity from marked stretching to actual tearing of capsule and ligaments, with certain degrees of subluxation. In order to be successful, therefore, the therapy for such conditions must adequately anticipate the extent of the pathology. In brief, the accepted treatment of sprain is: rest by means of immobilization, local applications for accelerating circulatory response, and sufficient time to allow the injured tissue to heal. Some types of sprain, for instance that of the ankle, do well on this regime. Given a sprain involving a deeper joint, however, with marked muscle spasm and some degree of deformity, the carrying out of this routine of immediate immobilization and prolonged rest may afford little correction or relief. Rather more logically, in such cases one would be prone to manipulate gently the involved joint, in order to correct whatever degree of malalignment or subluxation may have occurred incident to the tearing or stretching of the ligaments or capsule. In this manner, the normal relations of the joint are restored, the torn soft tissues are more correctly approximated, and the muscle spasm is more effectively and permanently allayed.

Instances of this sort are frequently demonstrated in injuries to the

cervical region of the spine. Reference is made particularly to those types of injuries to the neck, which, in spite of seemingly negative roentgenograms, present a definite clinical picture of sprain or subluxation. There is not only debilitating, persistent pain, but muscle spasm and the asymmetrical pattern of torticollis or wryneck are also present. Even in this region, a very definite list is noted with lateral inclination of the head on the neck and varying degrees of rotation, as well as impairment of motion or actual locking. Immobilization of the part in this particular position might serve to preserve the deformity and prolong the pain. The incidence of this type of injury is steadily increasing in direct proportion to the incidence of automobile mishaps. Condemned as it were by negative roentgenograms, very often such patients wander through many hands until they are finally consigned to the diagnostic category of neurotics or malingerers. Periodic sessions of steady traction and gentle manipulative manoeuvers without anaesthesia, but under a state of self-induced relaxation, have resulted in the successful restoration of normal cervical alignment, with the attitude of the head properly related to the neck, and the obliteration of the painful and deforming muscle spasm. Then heat and prolonged rest are found to be more effective therapeutic aids. The advent and development of laminography engenders the hope that in the near future the actual status of these lesions may be more definitely defined and their true clinical nature more accurately appraised.

One thinks of manipulating the deeper joints with a certain amount of trepidation. Why we do not hesitate to manipulate superficial joints, such as a subluxated shoulder, and yet withhold entirely from manipulating a deeper joint, such as the very important sacro-iliac, is difficult to understand.

Confronted time and again with these cases of acute low-back pain only to have the standardized methods of treatment fail, it seemed entirely reasonable to suppose that manipulation might correct whatever possible malalignment had been brought about. The manipulative technique for the treatment of low-back conditions which Baer developed some twenty years ago required the administration of an anaesthetic. Since many of these cases require more than one manipulation, the problem of repeated administration of anaesthesia had to be considered. Again, such a technique as could be carried out effectively without anaesthesia would certainly have a more practical place in the emergency treatment of low-back sprain.

## CONTRA-INDICATIONS

In reviewing the hundreds of cases that comprise this series, it is especially notable that very few contra-indications have been encountered. In discussing the subject of contra-indications, one presupposes satisfactory relaxation of the patient and a manipulative technique that is neither rough nor unduly forceful. Strength should not be mistaken for skill. If these conditions do not obtain, it is quite likely that undesirable

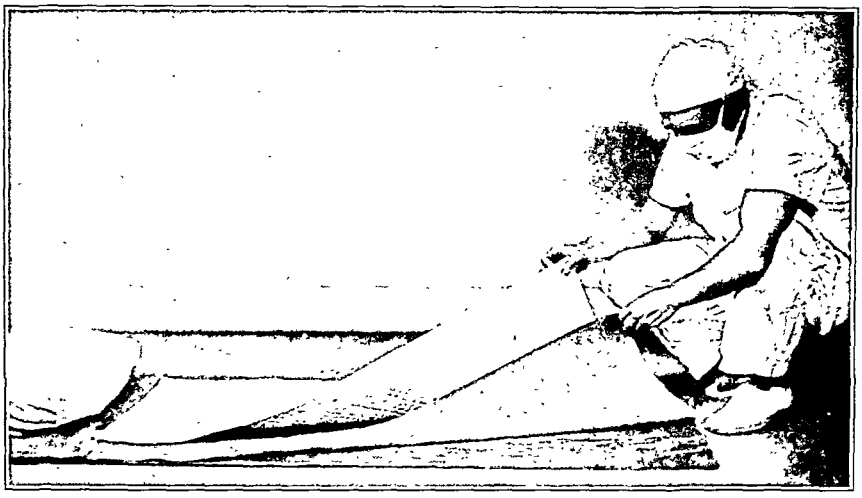


FIG. 1

The pad used for manipulation has a non-skid rubber base and a smooth leather cover, on top of which is placed a thin cotton pad plus a pillow.

and even dangerous results may ensue. Patients with chronic low-back pain should never be manipulated until they are adequately examined and the general condition fully appraised by means of a complete investigation. In this way, such definite contra-indications as fracture, neoplasm, tuberculosis, suppurative arthritis, advanced rarefaction secondary to hyperparathyroidism, etc., are ruled out and avoided. Uncompensated cardiac cases, of course, constitute a definite risk. Patients with inguinal hernia may be handled carefully and without undue danger.

### PREPARATION OF PATIENT

The manipulation is carried out with the patient lying not on a table but on the floor. In order to ensure adequate purchase in gripping the shoulder, ilium, etc., the patient is completely unclothed. Likewise, to prevent the mat from slipping on the floor, a sponge-rubber base (Fig. 1) is first laid down, and upon this the leather mat and the cloth mat are

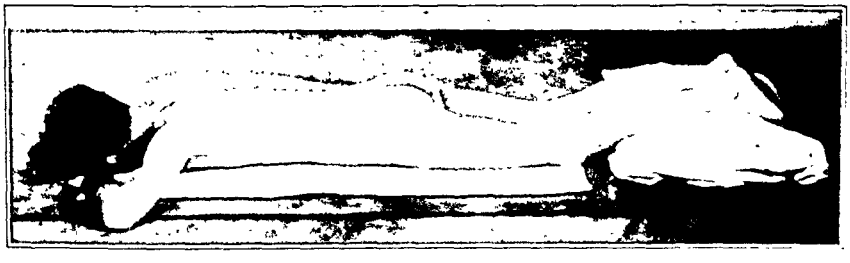


FIG. 2

The patient lies prone with the hamstrings relaxed, due to the fact that the legs and feet are slightly elevated over a pillow. Complete relaxation is essential to effective manipulation.

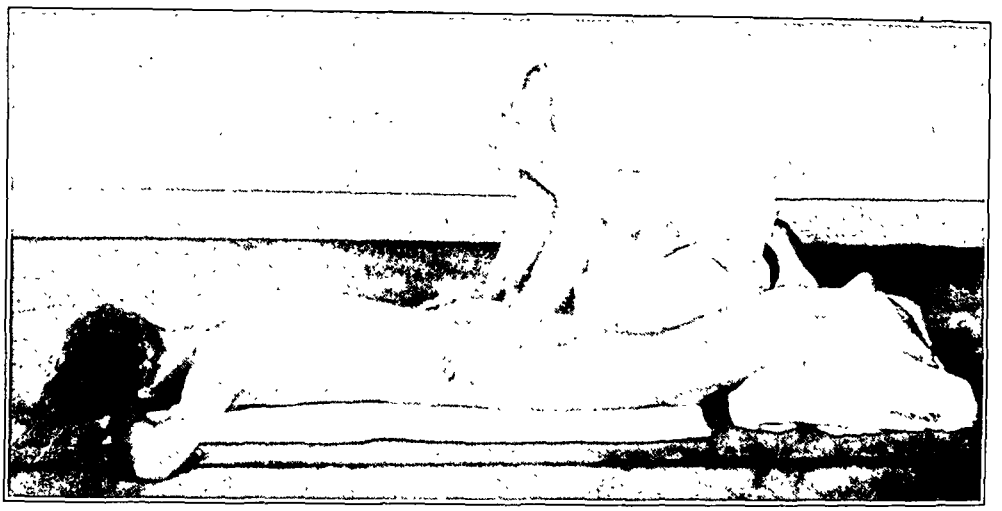


FIG. 3

Demonstrating the deep kneading massage of the gluteal muscles.

placed in turn. Very often these patients are in such acute pain that standing and moving are extremely difficult. For these reasons, they are taught how to get down to the floor properly, thereby saving themselves further muscle spasm or strain. By bending the knee on the well side and resting both hands on it, they gradually bring the affected knee down to the floor, followed then by the good knee. Once down upon both knees they then lean forward on their hands, in the knee-hand position. By flexing the elbow and bringing the trunk forward, the knees are gradually extended, the trunk is gently lowered to the floor, and the prone position is thus assumed. (See Figure 2.)

A survey of the patient in this prone position makes quite evident most of the deformities observed in the weight-bearing erect attitude,—the list (whether homolateral or contralateral), the spastic sacrospinalis muscles, and the very evident general rigidity of the patient. The sites

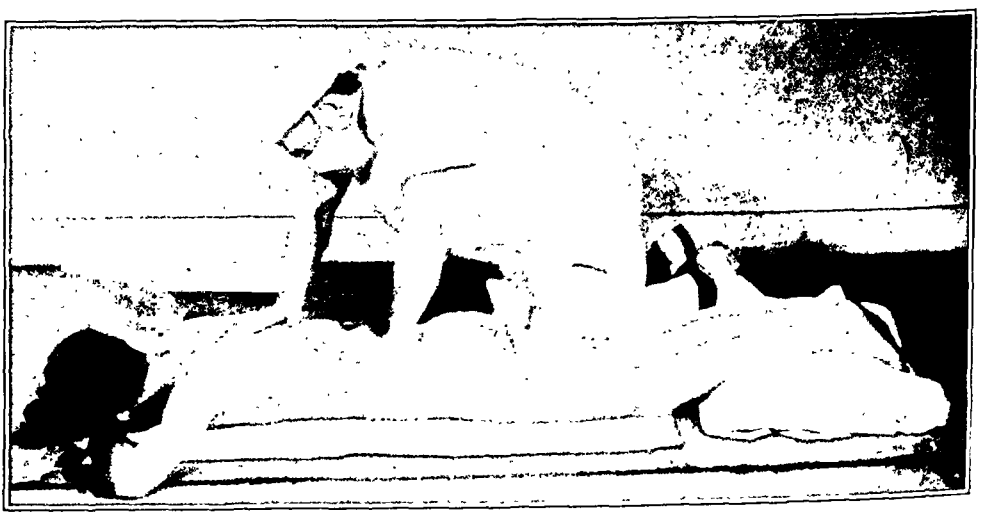


FIG. 4

Showing extent of massage over sacrospinalis muscles up to and including the shoulder girdle.

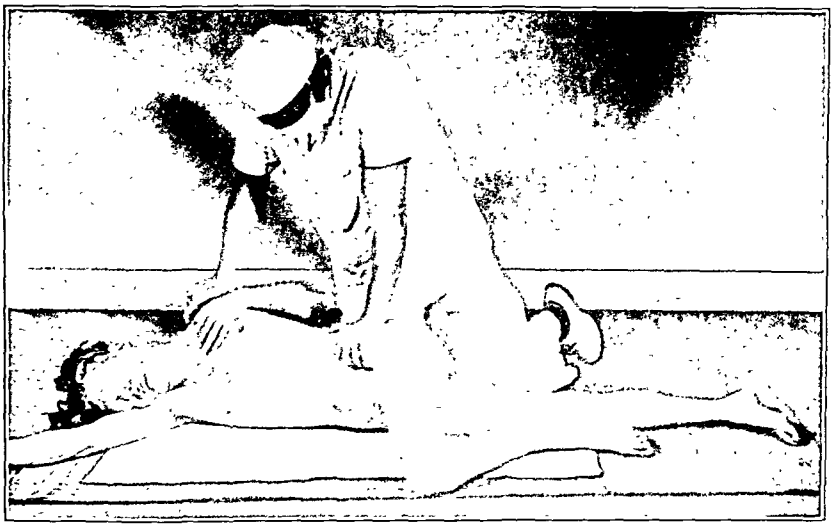


FIG. 5

Showing the position for Manoeuver 1 of the actual manipulation. The ilium is thrust forward and downward; the shoulder is rotated backward. (Flexes left sacro-iliac joint and stretches posterior sacro-iliac ligament. Some rotary movement to lumbosacral joint.)

of tenderness—whether in the lumbosacral, iliolumbar, or sacro-iliac regions, or in the gluteal or piriformis muscles, or in the ligaments—are still quite positive.

For this reason, massage of the gluteal muscles (Fig. 3) is begun carefully and gently, the patient meanwhile being induced to relax as completely as possible. When the pelvis begins to roll more easily from side to side with the gentle massage, the deeper kneading, which eventually includes the areas of tenderness and pain, is begun. From the pelvis, the

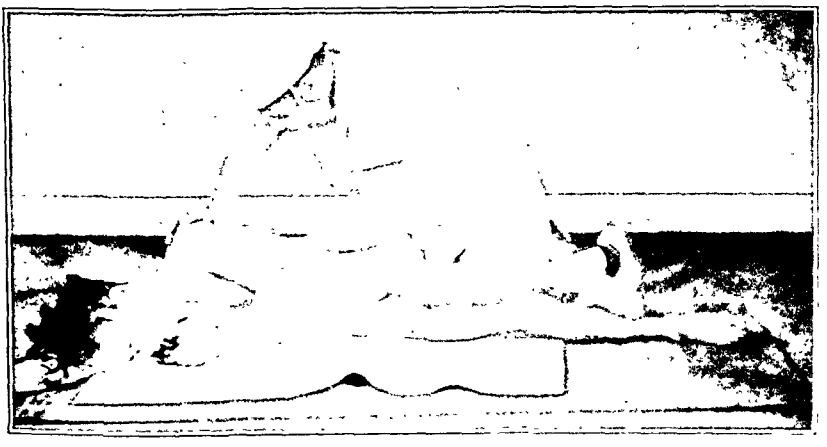


FIG. 6

Manoeuver 2—reverse of Manoeuver 1. (Extends left sacro-iliac joint and stretches anterior sacro-iliac ligament; also rotates lumbosacral joint in opposite direction to Manoeuver 1.)

course of massage proceeds to the paravertebral areas (Fig. 4) and finally to the mid-thoracic region, so that the shoulder girdles are likewise brought into a state of as complete relaxation as is possible. This procedure is eminently successful in securing satisfactory preliminary relaxation in most cases. The greater part of its success depends upon the intelligent cooperation of the patient, since such relaxation at this time is largely self-induced. However, during the course of the manipulation, it will be noted that a more complete state of relaxation very definitely results from particular manoeuvers, and it is undoubtedly enhanced by the disappearance of the painful spasm of the affected sacrospinalis muscles.

## THE MANIPULATION

*Manoeuver 1*

The patient is taken from the prone position, following deep muscle massage, and is placed on his right side. The right knee and hip are extended fully. The left knee and hip are flexed. The left hand is placed over the left pectoral region. This position is arranged by the manipulator. Next the manipulator with his left hand grasps the left ilium firmly in the region of the anterior superior spine and holds the left shoulder with his right hand. He then executes a rotary or torsion movement, bringing the patient's shoulder backward and at the same time thrusting the ilium forward and downward (Fig. 5).

*Discussion:* An important phase of this particular movement is a sudden and prolonged downward and forward thrust to the ilium, which very often results in a snapping sound, at times relatively prolonged, which simulates the tearing apart of sheets of fly paper. This movement tends to shift the left ilium forward or to flex it on the sacrum, separating the posterior margins of the left sacro-iliac joint and therefore tensing and stretching especially the left posterior sacro-iliac ligament. The left iliolumbar ligament likewise is stretched because of the opposing movements of trunk and pelvis. This latter movement is responsible for a simultaneous rotary movement of the interlaminar joints of the lower thoracic and all of the lumbar vertebrae as well as of the lumbosacral joint.

*Manoeuver 2*

The patient maintains the position as in Manoeuver 1. The manipulator then reverses the movement bringing the shoulder forward and thrusting the left ilium backward and upward (Fig. 6).

*Discussion:* This manoeuver has a tendency to separate the anterior margins of the left sacro-iliac joint and to stretch, therefore, the left anterior sacro-iliac ligaments. The rotation and mobilization of the lower thoracic and lumbar interlaminar joints and of the lumbosacral joint are now in the opposite direction. Relaxation of the sacrospinalis group very often occurs at this time with beginning correction of the list.

*Résumé:* In these two manoeuvers, the left sacro-iliac joint has been primarily mobilized with secondary mobilization of the lower thoracic, lumbar, and lumbosacral interlaminar joints and of the lumbosacral joint.

*Manoeuvers 3 and 4*

The position of the patient is now reversed. He is taken from the attitude of resting on his right side and placed on his left side. The left knee and hip are extended fully, and the right knee and hip are flexed. The right hand is placed over the right pectoral region. The manipulator executes the torsion or rotary movement already described and then follows with its reverse.

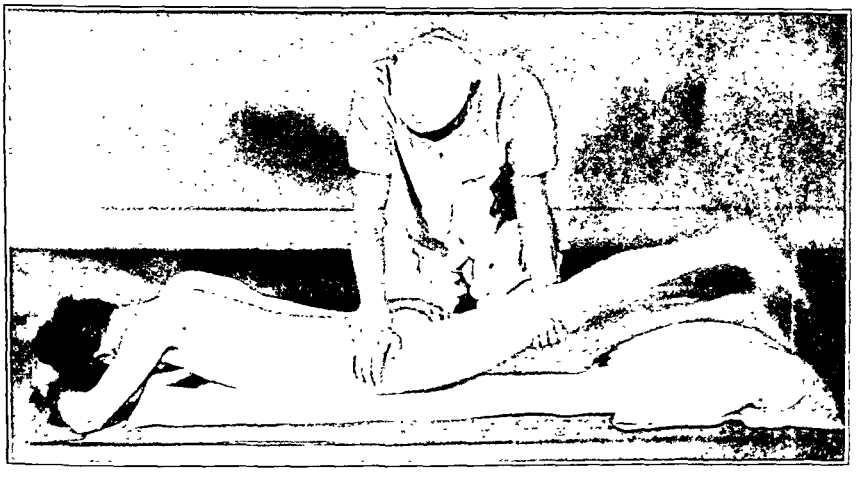


FIG. 7-A

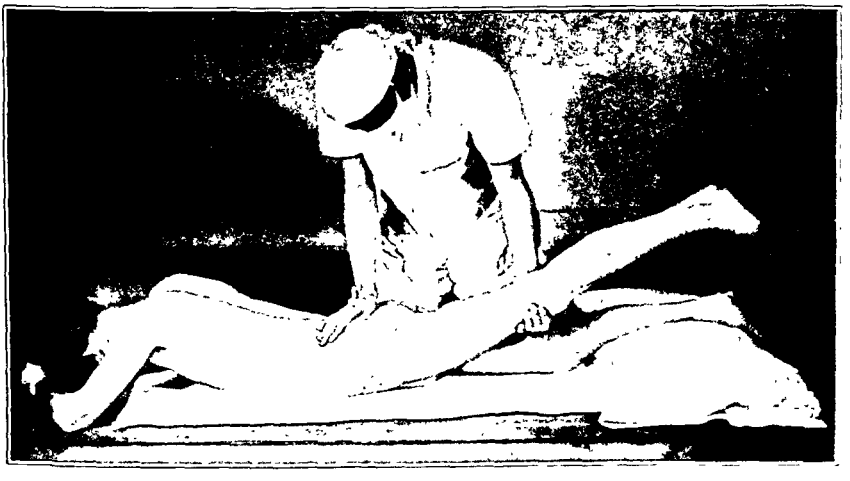


FIG. 7-B

Manoeuvers 5 and 6—hyperextension of thighs: first with the fulcrum on the ilium; second, with the fulcrum on the sacrum. In many cases, the fulcrum on the sacrum creates much more pain than when it is on the ilium. (Primarily stretches iliotibial bands; secondarily rotates sacro-iliac joints clockwise on sacrum.)

FIG. 8-A



FIG. 8-B

Manoeuver 7—passive flexion of spine at lumbosacral level, plus rotation of pelvis with spine in acute flexion. (Flexion and rotation of lumbosacral joint; stretching of sacrospinalis muscles.)

FIG. 9-B



FIG. 9-A

Same procedure as shown in Figs. 8-A and 8-B, using canvas strap when patient's weight is too much for lone manipulator to manage.



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*Discussion:* These manoeuvers tend to separate the anterior and posterior margins of the right sacro-iliac joint, thereby stretching the associated anterior and posterior sacro-iliac ligaments. The rotary movement of the lower thoracic, lumbar, and lumbosacral interlaminar articulations is

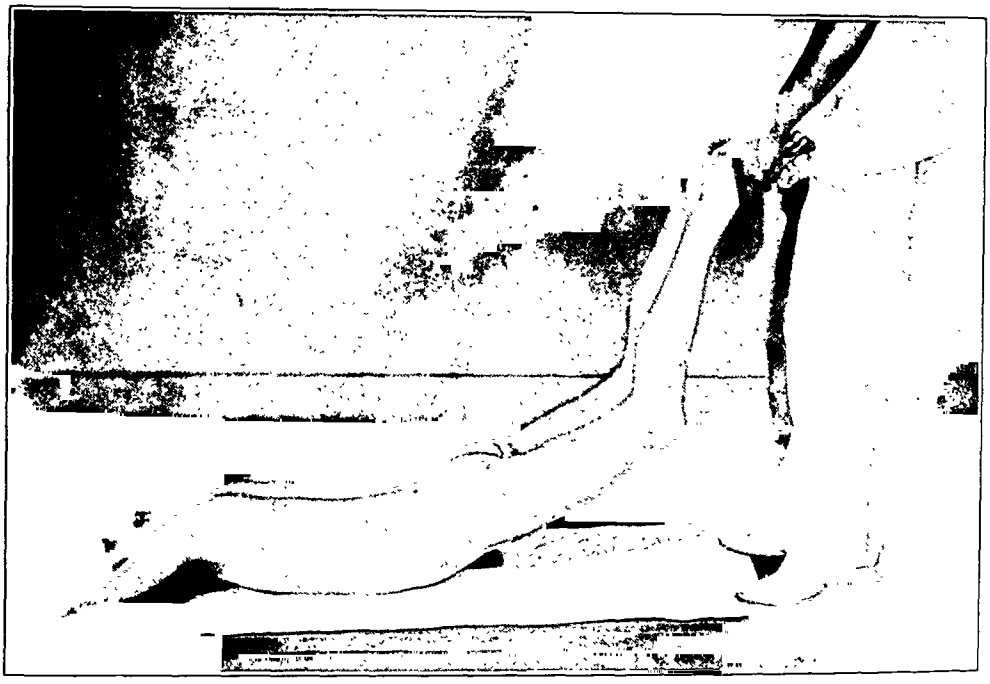


FIG. 10-A



FIG. 10-B

Manoeuver 8—hyperextension of spine plus rotation of pelvis, first to left and then to right, with spine in hyperextension. (Lumbosacral manoeuver, resulting in hyperextension plus rotation of joint.) The legs are likewise moved from left to right, so as to describe an arc in relation to the trunk. Has tendency to efface list by mobilizing lower thoracic and lumbar spine in lateral direction.

here reversed, and the iliolumbar ligament and the sacrospinalis on this side are stretched.

*Résumé:* Manoeuvers 3 and 4 primarily mobilize the right sacro-iliac joint with secondary mobilization of the lower thoracic, lumbar, and lumbosacral interlaminar articulations in a direction the reverse of that obtained in Manoeuvers 1 and 2.

*Manoeuver 5*

The patient assumes the prone position. The manipulator then places his right hand forcefully over the left gluteus maximus, being *careful not to bridge the sacro-iliac joint* (Fig. 7-A). He then hyperextends the patient's left thigh with his left hand (care being taken that the knee is fully extended).

*Discussion:* This usually produces severe pain on the involved side, especially if there is a contracted tensor fasciae latae present. At times the response is more painful if the manipulator's right hand presses down on the sacrum only (Fig. 7-B), while the leg is being hyperextended. This is apparently the result of increased leverage on the sacro-iliac joint.

*Manoeuver 6*

Similar manoeuvers are carried out on the opposite thigh.

*Résumé:* These Manoeuvers 5 and 6 are primarily effective in the direct stretching of a contracted tensor fasciae latae, as well as in the rotary mobilization of the sacro-iliac joint. Secondarily, they serve to stretch contracted flexor muscles of the hip.

*Manoeuver 7*

This manoeuver is one in which the weight of the patient's trunk is used opposite the weight of the patient's legs to bring about flexion of the lower lumbar spine and finally of the hips. With the patient lying prone, the manipulator stands directly over the patient's pelvis (to protect his own back from strain), grasps the anterior superior spines, and with the patient as fully relaxed as possible raises the patient from the floor, causing him literally to "fold up". (See Figure 8-A.) While maintaining this position, the operator rotates the patient's pelvis first to the left and then to the right. (See Figure 8-B.) If the patient's weight is too great for the manipulator, this same procedure is carried out using a belt, so that two manipulators carry out the same movements of flexion and rotation as described. (See Figures 9-A and 9-B.)

*Discussion:* This manoeuver primarily mobilizes the lumbosacral joint and the interlaminar articulations, first by flexion and then by opposing rotary movements. It is especially painful in lumbosacral involvements, although pain is occasionally complained of in cases of sacro-iliac involvement. Secondarily, the manoeuver stretches the contracted sacrospinalis muscles.

remarkably well adapted for the strenuous work which it must do in primitive life.

## EMBRYOLOGY

In tracing the evolution of the limbs, and especially of the knee, from the lowest vertebrates it is remarkably evident that, despite tremendous changes in other organs of the body, man has retained a great deal of the primitive features of the limbs. The bones of the legs of most mammals became greatly modified—for instance, the comparative elongation of the legs in horses and the disappearance of limbs altogether in whales—whereas in man, despite modification for plantigrade life, the original plan of structure is still clearly apparent.

Thus, in accordance with the biogenetic law or recapitulation theory, we should see the development of the limbs through the evolutionary stages in the embryo of man. At the end of the fourth week an elongated ridgelike elevation is seen on the dorsal border of the embryonic body. The limb buds arise from this ridge. It is held that this lateral ridge represents a row of fins and the limbs are specialized fin rays. These buds grow and extensions grow into them from the muscle plate and skin plate of each of the segments opposite the origin of the bud, and a nerve process from each of the corresponding segments of the spinal cord is sent into this mass. This segmental origin is seen only in the lower vertebrates and is inferred for the higher vertebrates.

By the seventh week the cartilage centers have appeared for the majority of the bones of the lower extremity. In the earliest stages the limb buds are so placed that the lower limb is rotated outward, while the upper limb is rotated inward. This is a position normally found in the primitive amphibians. This period, reached about the second month, may be called the reptilian stage.

Further development takes place, so that the cartilaginous skeleton gradually shows centers of ossification as the limbs elongate.

The knee joint up to the second month is a dense mass of tissue. The joint is flexed at nearly a right angle. The limb bones are formed from a center of chondrification within the unjointed skeletal blastema. At the periphery of these centers growth proceeds most rapidly, so that the centers approach each other, leaving the original blastema between them. This dense tissue or interchondral disc gives rise to the structures within the joint. A membrane called the perichondrium surrounds the growing cartilage and is derived from the peripheral part of the blastema. By the ninth week a joint space forms by the disappearance of the mesenchymal cells, first at the periphery and finally in the center. The perichondrium bridges across the limb segments to become transformed into a capsular ligament. In front of the joint this becomes denser to form the quadriceps tendon. The capsule now becomes lined with cells of the perichondrium to form the synovial membrane. The cartilaginous origin of this membrane is shown in certain pathological conditions in the adult

*Résumé:* This manoeuver, of course, is primarily intended for sacro-iliac mobilization.

### FOLLOWING MANIPULATION

The patient resumes the prone position. He is now shown how to progress from the prone position to that of standing with the least effort and likelihood of further strain. It is definitely believed that many backaches are prolonged because of trauma produced by improperly executed movements. Accordingly, the patient is asked now to change from the prone to the standing position by first coming to the knee-hand position, keeping the spine arched in flexion as much as possible. When the hands approach the knees, the patient is asked to put the good foot forward (the foot opposite the site of pain), placing it squarely on the floor, to lay both hands on the flexed knee, and to push downward, thus using the arms and the shoulders to extend the spine on itself and on the hips, instead of employing the back muscles normally coming into play in such a movement. Patients invariably welcome the relative ease with which they are now enabled to change position.

### POST-MANIPULATIVE ROUTINE

Following manipulation, the comparative ease with which the patient moves about attests the relief of muscle spasm and the acute radiating pain. This outcome would prove quite short lived in many instances if the patient failed to observe more or less complete rest for a given interval. For this reason, when patients are manipulated in the hospital, the bed is immediately made ready for them. There are boards under the mattress. The mattress is never an inner-spring type, but one made either of felt, hair, or kapok. The author feels that the inner-spring mattress is the most debilitating of modern contrivances, and constitutes a curse of the present era. Pillows are assembled in the middle of the bed, and the patient is shown how to get into the bed properly.

He steps up on the stool with the right foot (given an involvement of the left side), followed by the left foot. Both hands and the right knee are placed on the bed. Bearing all weight on the right knee, he then brings up the left knee and assumes the knee-hand position on the bed. Moving over to the middle of the bed, he lies prone over the pillows, thus flexing the low back. Infra-red heat at a distance of thirty inches is applied for thirty minutes. This latter routine is repeated every four hours. Twice a day, the patient practises alternate straight-leg raising, and he is manipulated as often as the condition warrants. Special attention is paid to nursing details, and no type of bed pan other than the special orthopaedic bed pan is ever allowed. The ordinary type of bed pan very often aggravates or precipitates an acute attack as quickly as would any other awkward movement and should be avoided. In getting out of bed, the patient assumes first the prone position, then the knee-hand position; he then moves the knees over to the edge of the bed, and, bearing



FIG. 11

Manoeuver 9—passive straight-leg raising. (Modification of Baer's technique,—counter-clockwise rotary movement of sacro-iliac joint.)

*Manoeuver 8*

The patient is in the prone position. The manipulator takes hold of the patient's feet and raises up the lower extremities wheelbarrow fashion, hyperextending the lower thoracic, lumbar, and lumbosacral interlaminar joints (Fig. 10-A). Next, hyperextension being maintained, first one and then the other thigh is dropped, so as to rotate the pelvis also (Fig. 10-B). The legs are also carried from left to right, so as to describe an arc in relation to the trunk. This has a tendency to efface the list by mobilizing the lower thoracic and lumbar spine in the lateral directions.

*Discussion:* Hyperextension of the lumbosacral joints is primarily intended, although the manoeuver rotates the ilium forward on the sacrum and tends to give clockwise rotation to the sacro-iliac joints.

*Manoeuver 9*

Passive straight-leg raising, according to the Baer technique of flexing the hip joint with the knee fully extended, is carried out on both sides. The pumping movement is used to increase the range of flexion when pain is encountered and better relaxation is desired. (See Figure 11.)

*Discussion:* It is noteworthy that, when this manoeuver is carried out without anaesthesia, and when passive straight-leg raising is carried out on the affected side, the pelvis on this side occasionally rises upward from the floor and rotates to the opposite side. This results from the patient's attempt to substitute abduction for forced flexion, in order to escape further pain. Hence, the assistant operator holds down the iliac crest on the affected side.

CASE 3. *Lesion:* Localized tenderness over the left iliolumbar ligament, the left gluteal region lateral to the posterior superior spines, and most marked over the left posterior sacro-iliac ligament.

*Etiology:* L. D. L., male, fifty-three years of age, a manufacturer, slipped on the ice. His effort to prevent falling precipitated an acutely painful back. At the time, he was under an internist's care for a chronic cardiac disability as well as an asthmatic condition. There was also present an old large right inguinal hernia.

*Treatment and Course:* The patient was seen in the home. Following manipulation the patient, who previously had been unable to move freely, was able to get up from the floor and walk to his bed. On the following day, he was writing at his desk and apparently quite comfortable. There was some slight residual soreness. Several hours later, in stooping to tie his shoes, another attack of pain was precipitated which was again relieved by manipulation. Two days later, the patient left on a trip. No further episodes have interrupted his regular routine.

This latter case is presented primarily to emphasize the point that manipulation is not a drastic or dangerous procedure if properly carried out.

CASE 4. *Lesion:* Anterior displacement of the sacrum on the fifth lumbar vertebra, manifesting itself as intractable low-back pain without list or radiation, with severe exacerbations and symptom-free remissions, unaltered by previous diligent treatment and several intervals of hospitalization.

*Etiology:* G. V. R., male, aged forty-six years, a manufacturer, experienced the initial attack in 1930. Following admission to Barnes Hospital in June 1937, roentgenograms in the supine and standing positions disclosed the lesion already described.

*Treatment and Course:* Following several manipulations, the patient was comfortable enough to return to his daily routine wearing an Osgood belt. Residual pain gradually disappeared. The patient was checked at several monthly intervals, at which times he declared himself to be asymptomatic. In January 1938, he was readmitted by ambulance with a severe acute attack. He was manipulated once following admission, placed on post-manipulative routine, and discharged on the third day, again asymptomatic. From the beginning, he has been warned about recurring attacks and acquainted with the possible future necessity of a spinal fusion.

CASE 5. *Lesion:* Severe sciatica (acute exacerbation) of the left lower extremity of a year's duration, causing complete incapacitation.

*Etiology:* Indeterminate.

*Treatment and Course:* E. G., aged thirty-six years, a mail clerk, had been having intermittent attacks for a year. He was admitted to the Jewish Hospital where, during the course of a week, he was manipulated daily for three days and every other day thereafter. During this interval the list lessened considerably; there was quite definite surcease from pain; and all his movements were performed more normally. He has been busy in his daily routine for the past ten months without a recurrence.

CASE 6. *Lesion:* Intractable sciatica of the right lower extremity of two years' duration, originating in the region of the right sacro-iliac joint. Hypo-active right patellar reflex with moderate atrophy of the right calf group and slight obtundity to heat, cold, and touch in the right leg and foot. Lumbar puncture was negative.

*Etiology:* Indeterminate.

*Treatment and Course:* I. S., male, aged fifty years, a tailor, was admitted in a wheelchair to the Jewish Hospital on October 23, 1934. An absolute-alcohol injection was performed on November 7, 1934. Examination revealed loss of pain and of sensibility to touch in the region of the second, third, fourth, and fifth sacral vertebrae on the right, with urinary incontinence. The patient was readmitted on January 14, 1935, with the complaint of low-back pain and urinary incontinence. Before another alcohol injection

weight on the left knee, he lets himself down on the right foot, followed by the left.

The usual duration of hospitalization for the chronic case is ten to fourteen days; that for the acute case, from two to three days. On discharge, the patient is generally equipped with some type of support such as an Osgood belt or a high-back corset. He continues the routine of heat and exercises at home as he did in the hospital. A rather important phase of post-manipulative treatment is the education of the patient to the business of saving himself from further trauma and sprain in performing his daily activities. Besides the proper methods of getting in and out of bed, he is taught how to arise properly from a sitting position and *vice versa* (most important in lumbosacral involvements); how to lean over properly and to arise from a stooping position; and how to drive his car with the least fatigue. Patients seen in the office and the home are made to follow the same routine of complete rest, heat, and exercises that is prescribed in the hospital. With the satisfactory alleviation of pain, relaxation of muscle spasm, and correction of the list, the patient is again allowed to introduce himself into his usual normal employment.

## CASE REPORTS

The present manipulative routine is the combination of various individual manoeuvers adopted over a period of seven years in the treatment of some 327 patients complaining of backache. The following cases were selected as being typical of the kinds of low-back pain which respond favorably to this type of therapy. The multiple details of physical examination and of case investigation on a differential diagnostic basis have been purposely omitted for the sake of brevity.

CASE 1. *Lesion:* Acute low-back pain at the lumbosacral level, without radiation or list.

*Etiology:* S. W., male, aged thirty-six years, a gynecologist, attempted to unhook bumpers on the rear of a car one hour previous to examination.

*Treatment:* Manipulation with considerable immediate relief.

*Course:* The patient was seen in the office. He returned to his home, where the post-manipulative routine was followed. Two days later he was completely free from symptoms and has remained so to date.

CASE 2. *Lesion:* Low-back pain, localizing about the right posterior superior spine and the posterior sacro-iliac ligament, with a mild list to the left and radiation of pain down the posterior thigh (right) and, more recently, over the anterior aspect of the thigh and into the scrotum.

*Etiology:* C. B. J., male, thirty-eight years of age, an otolaryngologist, three weeks previous to examination, was seized with pain when attempting to lift a boat during a fishing trip; this had been aggravated by attempts at exercise and the long drive home.

*Treatment:* Manipulation with some immediate relief, but little change in the clinical picture.

*Course:* The patient was seen in the office. He returned home and observed the post-manipulative routine. Manipulation was again carried out on the following day. On the third day, examination disclosed subsidence of both signs and symptoms. Manipulation was deferred. Normal routine was adopted on the following day without any prescribed support. There were no subsequent attacks.

and treated. As a rule, it is much easier to correct the condition completely by treating the initial attack than by treating the latest of a series of attacks over a period of years.

In conclusion, the reason, apparently, that manipulative surgery without anaesthesia has been looked upon with disfavor by the medical profession is the general lack of understanding of its position and of its careful application to the proper case.

## SUMMARY

1. A manipulative technique performed without anaesthesia is advanced as a treatment for low-back sprain, whether it be acute or chronic.

2. The technique found its inception in the need for a means of affording immediate relief to those individuals who, in the course of some activity requiring muscle exertion, have been abruptly seized with acute back pain and rendered helpless. Later, it was found that these manipulations were equally effective in the more chronic back conditions.

3. It has been used during the past seven years in several hundred cases, yielding varying degrees of immediate relief in every instance, and gratifying recovery in the greater percentage of cases.

4. The treatment is selective in type, and its employment is restricted to those cases of low-back pain which, either directly or indirectly, are of sprain etiology, and include the following groups: anatomical variations (sacralization, impinging transverse processes, etc.), congenital anomalies, poor posture (contracted tensor fasciae latae, marked lordosis, etc.), dislocations (apophyseal subluxation, spondylolisthesis, etc.), fasciitis and myofascial syndromes, and sprains (acute or chronic) of traumatic etiology.

5. Its successful employment without anaesthetization of the patient enhances its value in emergency use.

6. Contra-indications depend upon the accuracy of the diagnosis. One presupposes satisfactory relaxation of the patient and a manipulative technique that is neither rough nor unduly forceful.

7. The post-manipulative routine emphasizes the importance of immediate and adequate bed rest; intervals of infra-red therapy and regulated exercises; the *proper* performance by the patient of routine every-day actions (such as getting up from a chair or sitting down, getting in and out of bed, leaning over to pick up an object, and driving his car) which, improperly done, tend to precipitate an acute exacerbation; and finally, in chronic cases, the temporary use of adequate support.

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was done, orthopaedic consultation was requested. Manipulations were advised. Following a series of these, the patient obtained relief from the pain, and his active movements were vastly improved. He was discharged on February 4, 1935, to follow a post-manipulative routine at home. On February 18, 1935, he was readmitted for a mild exacerbation, apparently precipitated by overzealousness of the patient in exercising. He was manipulated again, with prompt improvement, and was discharged.

## DISCUSSION

In this paper the author has attempted to present in some detail a manipulative technique that found its inception some seven years ago and arose from the need for effective and immediate treatment of low-back sprain. At that time, it was used entirely for acute conditions. Since that time, the results have proved phenomenal in so many cases that the treatment has been attempted in cases of chronic back strain, with as gratifying results. During the ensuing years, the technique has been employed in several hundred cases, and the results have been rather closely studied. In some types of cases, the patients reacted in a wholly favorable manner when only one side was manipulated. In other cases, they did not completely respond until the entire manipulative technique had been carried out. In acute cases, further attacks were prevented by the early initial manipulation; in chronic cases, many patients responded well enough after several manipulations to be considered cured, while many more were given marked relief and were saved from further attacks by post-manipulative instructions in performing carefully their daily routine duties.

This manipulative technique is not offered as a cure for all cases of low-back pain. Rather, it is presented as another adjunct to the physician's armamentarium in the treatment of *one group* of low-back conditions. It is not always sufficient in itself, but must be followed up by other orthopaedic measures. Postural defects not the immediate result of acute muscle spasm—such as pronated feet, internally rotated femora, relaxation of the lower abdominal wall, lordosis with an anteriorly tilted pelvis, contracted sacrospinalis muscles, flat chest and round back, etc.—are noted and corrected. By the systematic strengthening of the abdominal muscles and the stretching of the shortened sacrospinalis muscles, the pelvic tilt is corrected and the abnormal lordosis is obliterated. An occasional patient presents a marked anterior tilt of the pelvis and, as demonstrated by the Ober abduction and Ely tests, a definitely contracted fascia lata. Routine corrective exercises are definitely impeded by the shortened fascia, and, in these instances, section of the fascia according to the Ober technique hastens the correction of the abnormal pelvic tilt, allowing for more effective shortening and strengthening of the abdominal muscles. Following failure of the conservative regime, the various operations for the correction of known anatomical defects must be considered. This alternative fortunately has not been a frequent one in the author's experience. The likelihood of a favorable prognosis in the conservative treatment is much enhanced, of course, the earlier the condition is seen

# ADAMANTINOMA OF THE TIBIA

## A Report of Two Cases

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*From the Hospital for Joint Diseases*

Until the year 1913, a case of primary epitheliomatous tumor of the bone of an extremity had never been recorded in the literature. Many primary tumors of bone of endothelial origin had been described, but Fischer reported the first epithelial bone tumor, a primary adamantinoma of the tibia. This tumor is apparently identical with that recognized in the jaw under the names "adamantinoma", "adamantoblastoma", and "epithelial odontoma", arising from the enamel-forming elements of the developing tooth of a four-months' foetus. Extramaxillary adamantinomata have been reported in the neighborhood of the pituitary gland.

The report of Fischer's first case was concerned largely with the difficulty of the microscopic diagnosis, very little space being devoted to the clinical side. In this case, the involved portion of bone was resected and an osteoperiosteal graft from the sound leg was inserted. Eight months after the operation, the patient was in good health.

In 1930, Richter reported the second case. Under the diagnosis of myelogenous sarcoma (roentgenographic diagnosis), the leg was amputated above the knee. The chief difference in these two cases was in the age of the patient,—Fischer's patient was a man thirty-nine years old, and Richter's patient was a boy twelve years old. They resembled each other in that a definite trauma was reported in both cases, the tumor was in the same position in the tibia, operation was performed under the diagnosis of sarcoma, and the pathological picture was identical.

The third case was reported by Baker and Hawksley in 1931. The patient was a man forty-six years of age, also with a definite history of injury to the tibia. The roentgenographic diagnosis was myeloma. The operation consisted in a subperiosteal resection of about four inches of bone at the tumor site. Convalescence was uneventful, and there had been no recurrence two months after operation. The subsequent history in this case is not recorded.

In Ryrie's case, reported in 1932, an outstanding fact was the long latent period,—the trauma in 1913 and the appearance of a swelling in 1923. This tumor was diagnosed as a sarcoma, and amputation was advised and refused. In 1931, eighteen years after the injury, the tumor area was "scraped out". The material was examined by a pathologist and reported as adamantinoma. Six months later, the tumor recurred and grew rapidly, and amputation was performed. In this case, even in the recurrence, the tumor was confined strictly to the bone.

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whereby synovial villi give rise to cartilaginous nodules. Remnants of the interchondral plate project into the gap between the articular margins to form the menisci.

The thickening of certain parts of the capsule depends upon the strains to which the joint is subjected. The front portion was described as early showing strength to form the quadriceps tendon. Later the posterior portion becomes strengthened to prevent overextension. In man the condyles of the femur developed toward the popliteal space, thus isolating a part of the posterior capsule which remains within the joint and forms the cruciate ligaments.

We have seen how the reptilian knee joint revealed three menisci, due to the articulation of the fibula with the femur. Eventually, in the progress of evolution, the fibula became excluded from the joint and the fibulofemoral disc was included in the tendon of the popliteus.

In the embryo the upper end of the fibula is being excluded from the knee joint about the eighth week. At this stage there are five synovial cavities in this joint,—one between the patella and the femur, two between the femoral condyles and the primitive menisci, and two between the upper surface of the tibia and the menisci. About the fourth month these cavities become continuous, leaving the primary septa as the cruciate ligaments.

The circular form of the lateral meniscus and its continuity with the posterior cruciate ligament seen in the macaque are features in a knee joint where the power of rotation is highly developed. The menisci of the human embryo lose this circular form and the cruciate ligaments are only partly attached to them.

## THE FUNCTION OF THE KNEE JOINT

From a consideration of the comparative anatomy, one may determine the function of the various structures which make up the joint.

Man is the only animal to assume the completely erect posture, and the knee joint is completely extended while bearing the weight of the body. The condyles of both the femur and the tibia find their largest development in the human knee joint. This affords extra surface for weight-bearing and adds to stability. The patella, which in the lower animals is rather poorly developed and has a very limited excursion, is in the human knee much larger and thicker and moves into a position directly above the joint line when the knee is fully extended. The increased thickness of the patella carries the patellar tendon more anteriorly and thus increases the tension on the quadriceps. This principle is used in the violin to increase the tension of the strings, the bridge corresponding to the patella.

The cruciate ligaments have been a subject of considerable controversy as to their importance in joint stability. Many methods for their repair have been devised in the belief that they are necessary in the proper function of the joint. In the animals dissected the cruciate ligaments

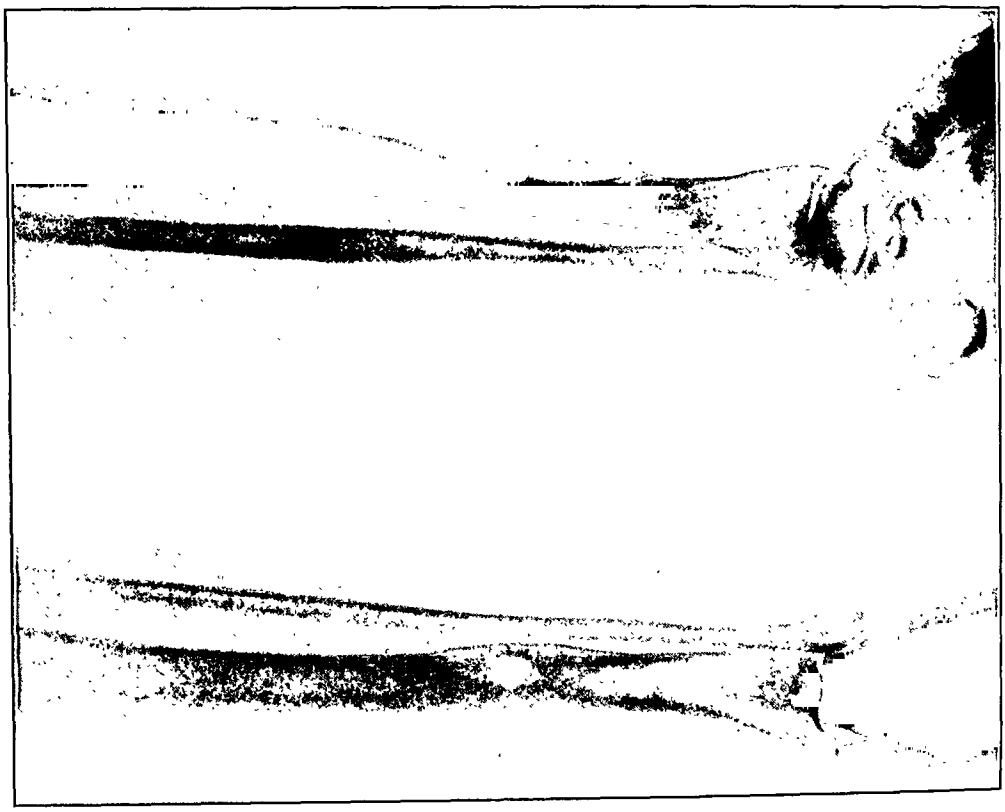


FIG. 2

Case 1. Showing the resected portion of bone with local recurrence.

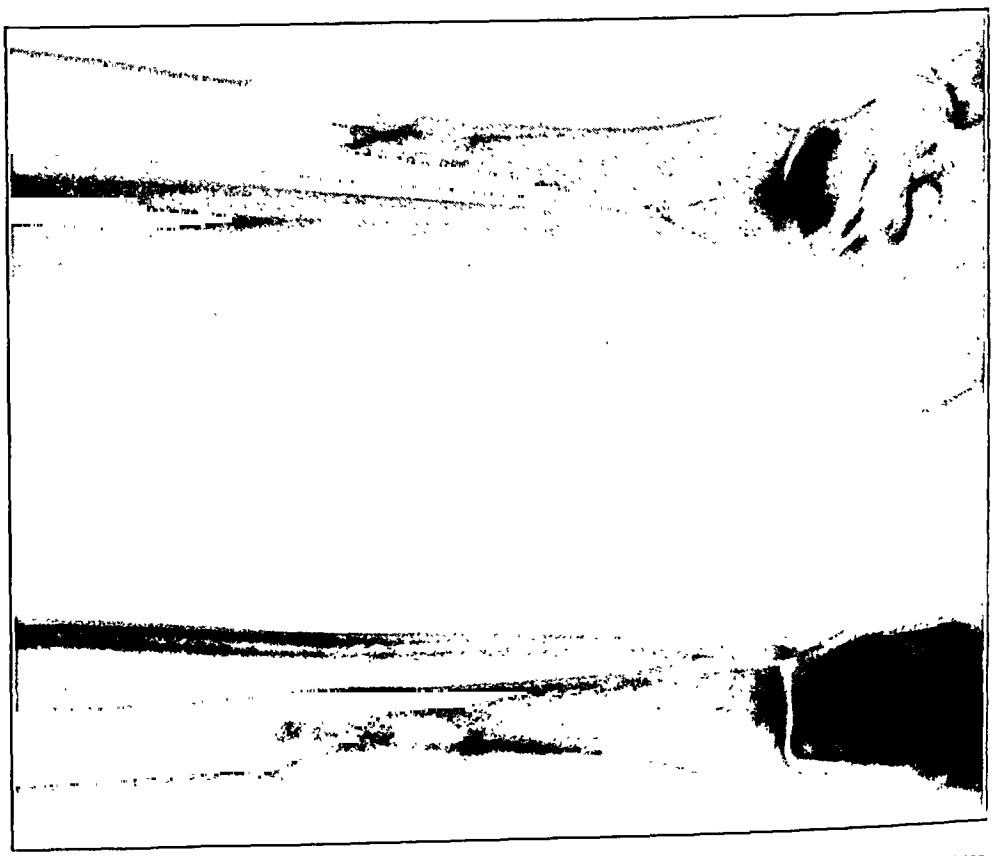


FIG. 1

Case 1. Tumor before operation.

The fifth case to be recorded, and the first in the American literature, was reported by Holden and Gray in 1934. In this case, as in the other cases, there was no evidence of tumor formation in any other part of the body. Also, as in the previous cases, there was a definite relationship between trauma and the lesion, and there was no invasion of the soft tissues. A preoperative diagnosis of bone cyst was made. The pathological diagnosis of malignant adenoma was made and was concurred in by three pathologists. The facts that no primary growth could be discovered in the body and that further histological study showed no structures from which the primary origin of such a neoplasm could be determined were puzzling. This patient was operated on in April 1931. The tumor, surrounded by healthy bony tissue, was removed by a mallet and a large gouge. In June of the following year a second operation was performed because of a recurrence,—the tumor was resected as in the previous operation, and the cavity was treated chemically. Following the second operation, a diagnosis of adamantinoma was made and roentgen-ray therapy was instituted. This patient has since come to amputation.

Another case recently reported by Bishop, the second in the American literature and the sixth case recorded, showed the characteristics of the previous cases. This patient, following local recurrence of the tumor, also came to amputation.

The most recent case has been reported by Rehbock and Barber. Here, the preoperative diagnosis had been a Brodie's abscess. Since only eight months have elapsed, it is too early to draw conclusions as to the ultimate outcome.

After reviewing all the cases to date, one must conclude that the diagnosis can be arrived at only from the histological examination. It would also appear that adamantinoma is malignant in that it frequently recurs, and it is not malignant in the sense that it does not metastasize.

Our cases, the fourth and fifth in the American literature, follow:

## CASE REPORTS

CASE 1.* I. T., a female, fifty-seven years of age, was admitted to the Hospital for Joint Diseases on March 26, 1934, with the complaint of pain in the left leg of four months' duration, following a bruise caused by striking the leg against a chair fifteen months previously. This had been followed by a swelling which at first was painless. This swelling had increased and had become tender. With motion of the ankle there was pain at the site of the swelling. There had been no treatment prior to admission.

The family history and the past history were irrelevant.

Local examination revealed a swelling of the left leg, about two and one-half inches in diameter, on the anterior surface of the tibia at the junction of the middle and lower thirds. This was sensitive to touch and non-fluctuant. There was slight elevation of skin temperature with a nodular induration of the skin.

Roentgenographic examination (Fig. 1) revealed "a fibrosis cystica of the tibia but the fibula was suggestive of early Paget's disease as shown by thickening of the cortex and periosteum; definite thickening of the cortex of the tibia above the site of pathology".

Dental examination disclosed an impacted lower third molar, but there were no signs of a cystic condition. The upper and lower dentures were false.

* From the Service of Leo Mayer, M.D.

Pelvic examination showed an enlarged uterus, which was movable and underflexed. Curettage was advised. The tissue removed proved to be negative.

On March 28, 1934, an exploratory operation was performed. A five-inch incision was made over the tumor mass. The tumor involved the periosteum and the cortex, but not the marrow cavity. The tumor, with the surrounding healthy bone, was removed *en masse* by means of a large gouge and mallet. The wound was closed without drainage, and a plaster-of-Paris cast was applied to the leg and foot.

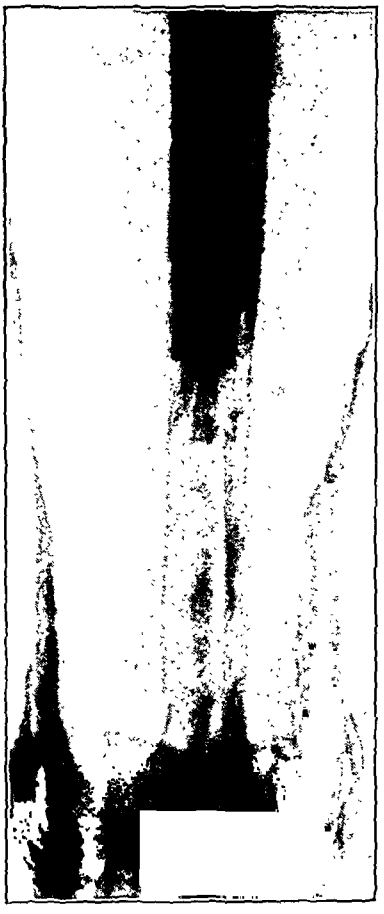


FIG. 3

Case 1. Resection of the tibia with graft *in situ*.

Postoperative roentgenograms revealed complete removal of the bone tumor. The pathological report was: "Adamantinoma of the tibia".

The wound failed to heal in certain areas, but the patient was discharged on April 18, 1934, to the Out-Patient Department. The wound continued to discharge a yellowish fluid, and marked excoriation of the adjacent skin or dermatitis was present. Despite repeated and varied applications, the ulcerated area failed to heal. During this interval, the patient experienced almost constant pain in the left leg, which was exaggerated by weight-bearing.

A roentgenogram (Fig. 2), taken on July 29, 1935, showed a recurrence of the cystic bone tumor. On August 12, 1935, after consultation with Dr. Milton Friedman, another resection of the tumor tissue was decided upon as irradiation was considered to be contra-indicated because of the unhealthy skin condition.

On August 28, 1935, a complete resection of the involved portion of the tibia, including the periosteum from five to fifteen centimeters above the internal malleolus, was performed. To fill in the resultant gap, a massive bone graft, pointed at either end, with periosteum from the opposite tibia, was inserted. (See Figure 3.) Later a portion of this graft sequestrated and had to be removed. The wound eventually healed after a most persistent and baffling dermatitis.

For the pathological diagnosis of the original tumor we are indebted to Dr. Henry L. Jaffe. The report on the resected portion of the tibia and periosteum follows:

"*Gross:* The specimen consists of a length of tibia measuring ten centimeters. On stripping the periosteum, which was only moderately adherent, the site of the previous operative intervention was disclosed by a hollow on the surface of the tibia. The surface of the bone presents two distinct elevations of rather firm soft tissue. On longitudinal section of the tibia, further details concerning these and other similar but completely intra-osseous nodules became apparent. They are rather firm, round to oval, low, and white in color. The smallest measures approximately six millimeters in diameter; the largest, almost twenty millimeters. They are eroding and destroying the cortex. They are very sharply demarcated both in the cortex and in the medulla.

"*Microscopic:* Section through the largest nodule shows a tissue whose histological architecture corresponds well with that ordinarily considered as typical for adamantinoma. [See Figure 5.] The striking feature of the lesion is that it provokes practically no periosteal reaction. It does not infiltrate the bone adjacent to the region of its growth. It induces no particularly rarefying or sclerosing changes in the neighboring bone. Some sections through the periosteal tissue contain nests of tumor in the region of the scar of the previous operation. One of the periosteal sections shows a small tumor nodule where this tissue was directly in contact with the bone.

"*Diagnosis:* Adamantinoma of the tibia (recurrent)."

The patient was subsequently readmitted for lengthening of the Achilles tendon for an equinus deformity. The wound healed *per primam* and the patient was discharged to the Out-Patient Department, wearing a leg brace to control the tendency toward bowing of the leg. After several months the patient was readmitted for an ulceration on the leg and a persistent dermatitis. This condition in time cleared up and the patient was able to walk. In February 1938, almost four years after the first operation, there was no sign of a recurrence. (See Figure 4.)

CASE 2.* E. R., a white female, eighteen years of age, on January 3, 1936, fell on an icy pavement. Following this there was a painful sensation in the right leg. She was given first-aid treatment at a city institution and was later removed to the Hospital for Joint Diseases with the leg in a plaster-of-Paris bandage.

The family history was negative and irrelevant.

The patient stated that four years previous to admission, while high jumping, she had struck her right leg on a wooden bar. The small abrasion produced at the time had healed quickly, but the leg had remained tender to pressure ever since. This tenderness had increased and for the past four months she had walked with a limp due to pain in the right leg on bearing weight. There was no pain at rest.

Physical examination, except for the local condition in the right leg, was negative.

Roentgenographic examination (Fig. 6) by Dr. Maurice Pomeranz revealed the following: "In the distal half of the shaft of the right tibia, with the exception of the distal metaphyseal area, a medullary, trabeculated, slightly expansile lesion is noted, through the proximal end of which an oblique pathological fracture, with slight displacement of the fragments, is seen. Irregular bone-productive changes are present throughout. The cortex, on the upper and anterior aspect at the site of the lesion, is irregularly eroded and a semilunar, circumscribed soft-tissue shadow is seen projecting through the muscle bundles. There is a negligible periosteal reaction. A few small,



FIG. 4

Case 1. Showing regeneration of bone from above and below at site of resection, two and one-half years later.

* From the Service of Samuel Jahss, M.D.



FIG. 5

Case 1. Photomicrograph of the histological specimen.

ovoid, rarefied, medullary lesions are seen at the junction of the upper and middle thirds of the shaft of the tibia. There is also a complete oblique fracture through the proximal end of the fibula with no displacement of the fragments. The chest plate shows no metastases."

The blood count was normal, and various other tests did not yield any additional information as to the nature of the pathological lesion.

A biopsy was performed on January 13, 1936, nine days after admission. A six-inch incision was made over the lower half of the right leg, exposing the site of the fracture and the tumor. There was a blood clot between the fragment ends. The cortex below the fracture was firm and trabeculated. When the cortex was removed, the marrow, for about three inches, was filled with a corrugated, encapsulated, grayish substance. This was scooped out quite readily with a bone curette. What we believed to be the entire tumor mass was removed, leaving a deep hole in the tibia. No definite diagnosis could be made from the gross specimen at the time of operation, and the tumor tissue was given to the pathological department.

The report of Dr. Henry L. Jaffe follows:

"*Gross:* The specimen consists of a considerable quantity of dense, fibrous tissue curetted from the marrow cavity of the tibia. The endosteal growth of this tissue was associated with thinning and rarefaction of the overlying cortex.

"*Microscopic:* Sections show fields of variably shaped cells, most of them being of

the spindle-cell to oat-cell type. They are of moderate size with vesicular nuclei containing nucleoli, pale and poorly perceptible cytoplasm and, for the most part, no discernible cell walls. Their arrangement in most areas is irregular. Scattered everywhere, however, are fair numbers of alveolar-like clusters. There are many places in which the cells assume a palisade arrangement as though demarcating the edge and tips of papillae. There is a considerable quantity of intercellular substance distributed throughout the tumor. This stains poorly. There are intracellular droplets of unidentified clear matter. Stroma is scanty. Giant cells are not seen, nor any considerable number of mitotic figures.

"*Diagnosis:* Adamantinoma of the tibia (diffuse or anaplastic)."

An additional note by Dr. Jaffe reads as follows: "This lesion is primary in the tibia and recurrence is to be expected. Metastasis is not an immediate probability. Radiation therapy will probably not prevent recurrence. Amputation is suggested as a curative measure in view of the extent of the lesion."

In February 1936, after consultation with our radiologist, Dr. Milton Friedman, radium therapy was instituted. After the wound had been reopened and the marrow cavity had been exposed, seven radium tubes, containing ninety-six milligrams of radium, were inserted into this marrow cavity. Two days later, these tubes in their vaselin-gauze pack were removed. The wound healed, and the patient was discharged in March 1936, wearing a plaster-of-Paris leg cast. Following this, the patient was observed in the Out-Patient Department.

A roentgenogram, taken on March 30, 1936, revealed what seemed to be an extension of the process, and one taken in April 1936 showed the same appearance with bone regeneration. However, when the plaster was changed in October 1936, the wound had broken down, the leg was swollen, and there were two foul discharging sinuses.

On February 23, 1937, a resection of the lower two-thirds of the right tibia was performed. The involved bone was dense and sclerotic and was removed *en masse*. The wound was packed with vaselin gauze and left open.

After examining the resected portion of the tibia, Dr. Jaffe again reported the presence of tumor tissue, and the microscopic sections again showed the pathological picture.

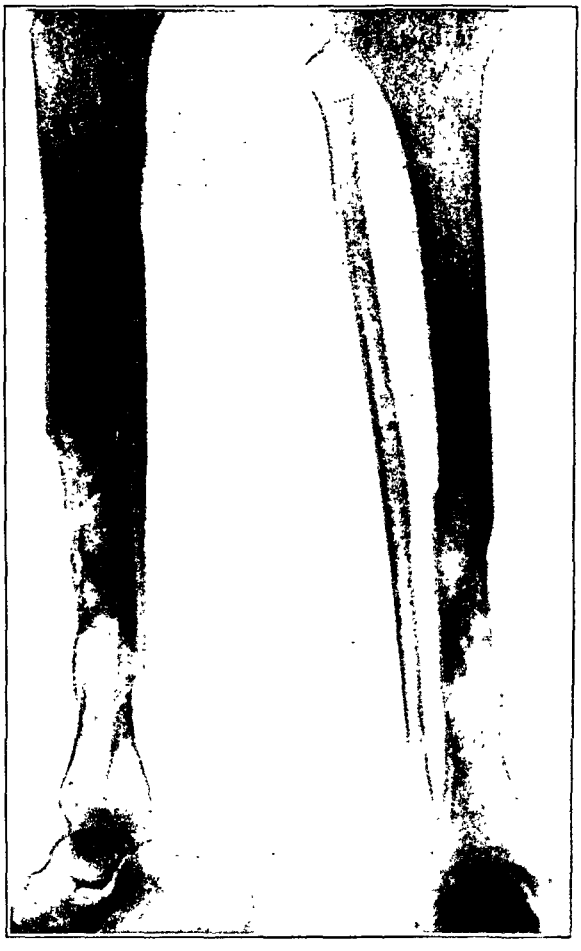


FIG. 6

Case 2. Showing site of fracture and tumor before operation.

Following the second operation, a high temperature developed, and the wound sloughed. Maggots, as well as urea crystals, were used on several occasions. Later, a pyocyaneous infection developed, which yielded to boric-acid dressings. In June 1937, the patient was discharged to the Out-Patient Department; the wound was still discharging. By November 1937, the wound had almost closed.

On February 14, 1938, the patient finally consented to amputation, and the extremity was amputated above the knee.

The report of the microscopic examination of the amputated specimen was as follows: "Sections show very extensive degeneration of the muscle; in places the latter is necrotic. The vessels throughout the section show marked thickening of all the coats and there is narrowing of the lumina of the arteries due to intimal thickening. Sections of the material filling the tibial dehiscence show this tissue to be fat and connective tissue, containing considerable amounts of tumor. The tumor is composed of closely compacted cells, most of which are spindle-shaped. Between the cells there is little, if any, intercellular material and the cells, themselves, present an occasional mitotic figure. The tumor seems to be invading the tissue along pseudo pad-like extensions, and, in places, the periphery of the tumor-cell masses seems to be demarcated by taller cells suggestive of basement epithelial cells. The tumor at this time presents the histological characteristics of the original tumor and those seen in the subsequent biopsies.

"*Diagnosis:* Adamantinoma of the tibia."

NOTE: In conclusion, we wish to express our appreciation to Dr. Leo Mayer and Dr. Samuel Jahss for their interest and help in reporting these unusual cases.

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# EWING'S TUMOR (ENDOTHELIAL MYELOMA)

## An Unusual Case Report with Necropsy

BY WILLIS C. CAMPBELL, M.D., AND J. F. HAMILTON, M.D.,
MEMPHIS, TENNESSEE

A necropsy report of a Ewing's sarcoma (endothelial myeloma) is of material value because necropsies of this tumor are exceedingly rare,—only thirteen such reports have been found in the literature. These thirteen cases were reported by Sycamore and Holmes; Melnick; De Santo; Connor; Porter, Lonergan, and Gunn; and Charache. Much doubt has been expressed, particularly by European pathologists, that there exists such a tumor as a definite entity. The following report is of further interest on account of the duration of approximately six years. This is a much longer duration than any case we have seen in this Clinic.

### CASE REPORT

*History*

M. B. (Registry of Bone Sarcoma No. 1828, our file No. 35279), white, female, aged twenty, came to our Clinic on January 15, 1935, complaining of pain and swelling in the left arm. The family history was irrelevant. The patient had had measles and mumps in childhood. She had complained of "rheumatism" in the left arm in the fall of 1931. This had lasted only a few days and she had had no fever. In 1933, while on a visit in Ohio, she had had another attack of "rheumatism" in the left arm. This attack was likewise of short duration and without fever. Three weeks after this attack, in August 1933, she had received a slight fall from a fence, resulting in a fracture of the left arm. She thought that the fracture of the humerus was sustained when the elbow struck the ground. The arm had been placed in a splint for a number of weeks, following which she regained almost complete function, but continued to favor the arm. She was told that the roentgenogram had showed some trouble in the bone at the time of the fracture. This was confirmed by the roentgenogram secured from Dr. H. E. Ward and Dr. H. W. Dierksheide, for which we wish to express our thanks. In December 1933 she had experienced *severe pain* in the arm with fever and delirium. She was confined to bed for ten days. She had experienced several similar attacks in the interval until the last attack, which had begun on December 30, 1934, and was the most severe of all of them. She had worked in a five and ten cent store during the Christmas season and had used the arm about as usual since the last attack. She had noticed a "knot" at the site of fracture ever since the splint had been removed. The arm had been enlarged for eight months previous to examination, and the muscles on the inner aspect of the arm had become harder.

*Physical Examination*

The patient was well developed and well nourished; she weighed 105 pounds and her height was five feet and one inch. The temperature was 98; the pulse rate, 90; and the blood pressure, 124/70. Aside from the left humerus, the physical findings were negative. The left shoulder was lower than the right. The acromio-epitrochlear measurements were as follows: right, twelve and one-half inches; left, eleven and one-quarter inches. There was a visible tumor in the upper third of the humerus. Palpation revealed a much thickened left humerus in the upper and middle thirds. No motion was felt at the site of the old fracture, but deep palpation elicited pain at this level. Arm



FIG. 1

August 25, 1933: Pathological fracture of the upper third of the humerus with definite destructive changes in and adjacent to the fracture site with soft-tissue swelling.

motion was as follows: abduction, 45 degrees; external rotation, 20 degrees; anterior extension, 60 degrees; posterior extension, 10 degrees. The radial pulse was palpable. Sensation in the forearm and in the hand was normal.

*Laboratory Findings*

The urine and blood were normal. The blood Wassermann test was negative.

*Roentgenographic Examination*

Roentgenographic examination, on January 15, 1935, revealed a destructive lesion involving the upper third of the shaft of the left humerus, solid union of the old fracture with some angulation, and swelling and increased density of the soft tissues around this region. The lungs revealed no metastases.

*Clinical Diagnosis*

A clinical diagnosis of Ewing's tumor was made.

*Biopsy*

A biopsy was done on January 16, 1935. The specimen consisted of three small pieces of blood-stained and oedematous soft tissue. The cut surface was pinkish blue, glistening, moist, and slightly granular. Some parts of it were myxomatous in appearance, while other areas resembled fish flesh and appeared to be quite devoid of blood. No definite capsule was seen.

The microscopic description was as follows: "This is a rich, cellular tumor growth. The nuclei of the cells are oval to round, for the most part, hyperchromatic, and vesicular. Nucleoli are noted. In places the cytoplasm is very faintly visible and takes a pale pink stain. Few mitotic figures are seen. The cells appear in sheetlike arrangement. In places the cells are concentrated in dense masses. These are found to be about blood vessels and in muscle and connective tissues. There is much hemorrhage here and there throughout the section. Blood vessels are numerous. The growth is invading muscle tissue."

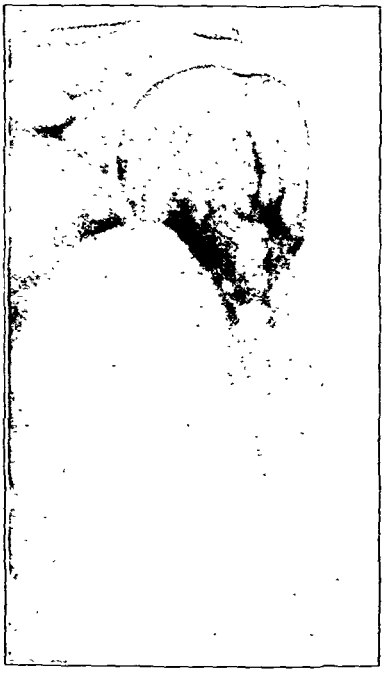


FIG. 2

January 15, 1935: Increased destruction of bone with faint onion-peel reaction at the lower portion of the tumor. The fragments of the pathological fracture are solidly united in satisfactory position.

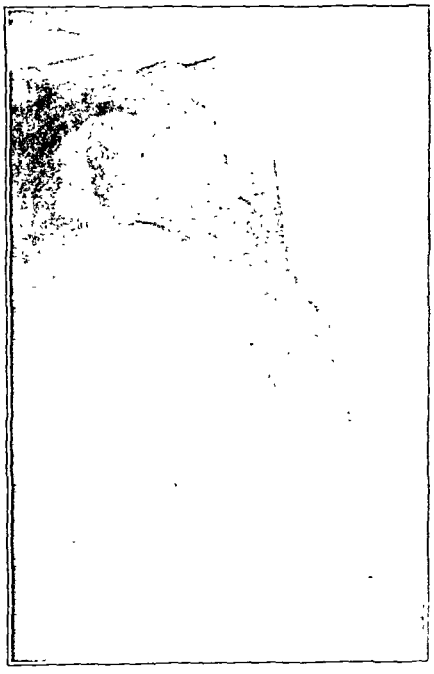


FIG. 3

June 10, 1936: Just before resection of the humerus and following roentgen therapy. The bone has increased in density.

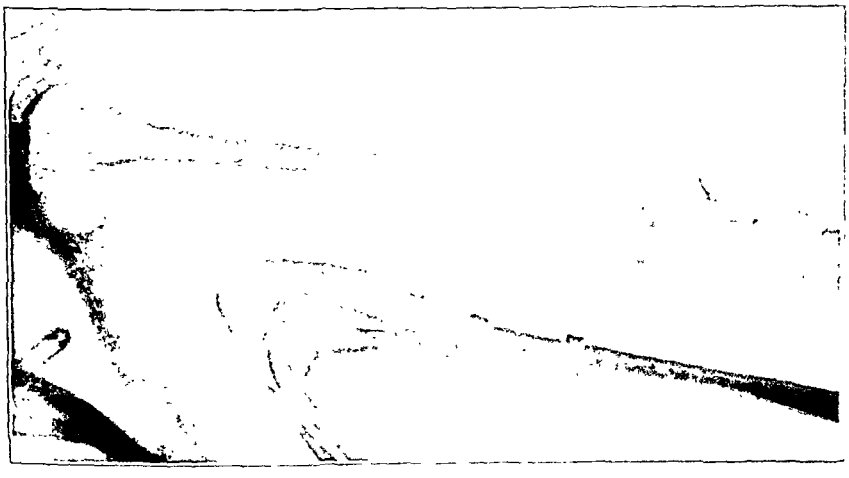


FIG. 4

August 26, 1936: Two and one-half months after operation. The upper three-fifths of the humerus has been resected and the fibula graft is held in situ by three rustless-steel wires.

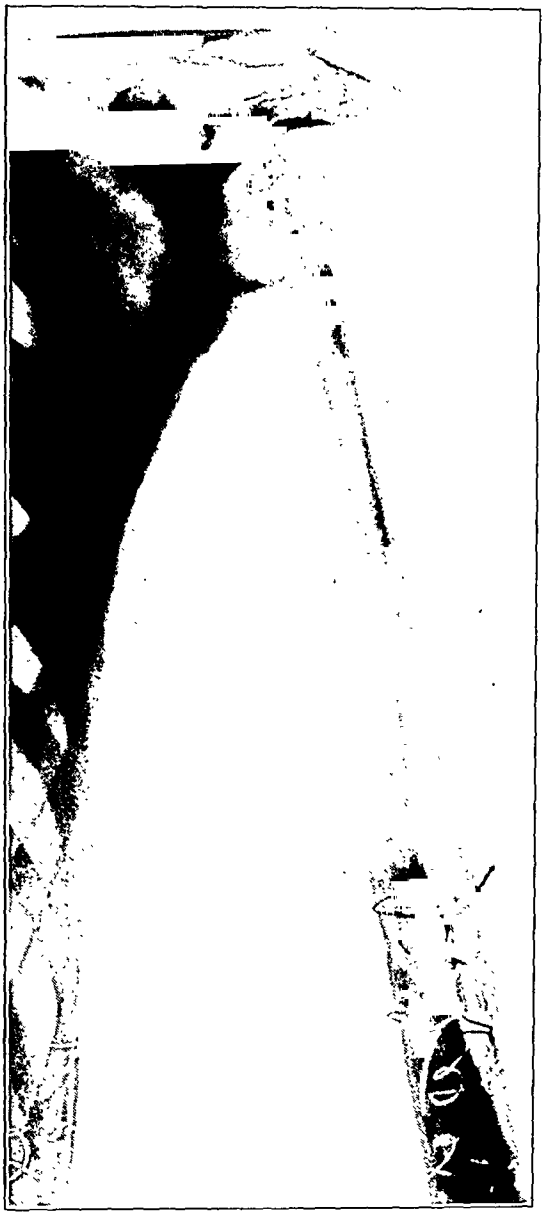


FIG. 5

February 11, 1937. Nine months after operation. Note the recurrence of the soft-tissue tumor lateral to the graft.

*Pathological Diagnosis*

A pathological diagnosis of Ewing's tumor (endothelial myeloma) was made.

*Treatment*

As the patient declined amputation, deep x-ray therapy was begun on January 16, 1935,—200 kilovolts, all given with copper filter, at a distance of fifty centimeters, and for ten minutes. She received in all seven courses of deep x-ray therapy, amounting to 15,900 roentgen units. On January 25, 1935, Coley's toxins were begun. Seven courses were given, extending through April 1936. A course consisted of three doses a week for six weeks, given intramuscularly. A rest period of at least two weeks was allowed between each course.

*Clinical Course*

The response to deep irradiation was excellent. The tumor, the pain, the soreness, and the local fever subsided fairly rapidly. The reactions to Coley's toxin were severe, resulting in anorexia and loss of weight, but between courses the patient gained weight and improved in every way. In June she had a slight flare-up with pain, slight swelling, and increased local heat at the site of the tumor. The local symptoms and signs disappeared following x-ray therapy just as had happened previously. Frequent roentgenograms of the arm were taken, all of which showed a progressive condensation and solidification of the affected part of the humerus but no metastases to the lungs.

An intermittent soreness, at times with some pain and local heat over the site of the tumor, appeared again about Christmas 1935. Because of this, and in spite of the fact that the roentgenograms were negative for additional changes, surgery was again advised and agreed to, following which resection of the upper three-fifths of the humerus was done on June 16, 1936. A right-fibula graft was substituted for the resected humerus, the head of the fibula being placed in the glenoid fossa. Union occurred, and following physiotherapy, the patient obtained a fair degree of function. On account of agonizing pain in the right hip, she was admitted to the Hospital for Crippled Adults, and a roentgenographic examination was made on February 11, 1937. Destructive lesions in the left ilium, adjacent to the sacro-iliac joint, and in the neck of the right femur with a pathological fracture and a soft-tissue tumor at the site of the primary lesion were found. No metastases were seen in the lungs. The clinical course of the disease was downward from this time on with rapid loss of weight, and pain that required opiates, freely administered. A few weeks after admission to the Hospital for Crippled Adults, the left arm in the region of the original tumor began to



FIG. 6

Necropsy specimen, showing the extent of the soft-tissue tumor.

enlarge, and death occurred on April 28, 1937. Upon post-mortem examination this enlargement of the left arm was found to be due to a large tumor growth.

## NECROPSY REPORT

*External Examination*

Examination showed a white female, aged twenty-two years, five feet and one inch in height, and weighing seventy-five pounds. The body was still warm, and the skin was white and dehydrated. There was marked emaciation with atrophy of the muscles. The eyes were sunken, and the lids were partly open. Sordes was present on the teeth.

There were two ulcers on the posterior and posteromedial aspect of the left elbow. A long healed scar on the anterior aspect of the left arm from the shoulder joint to the lower third of the arm and another scar over the lateral aspect of the upper third of the right leg were noted. The left elbow was flexed to a right angle. The right lower extremity was internally rotated. The entire posterior aspect of the torso had a bluish, mottled appearance. There was a firm nodular tumor growth over the upper two-thirds of the left arm in the region of the former operation. The lymph nodes were not enlarged.

*Internal Examination*

The head was not opened. When the body was opened, there was noted marked atrophy of the subcutaneous fat.

*Pleurae:* A small dark-red firm mass, two centimeters in diameter, attached to the left parietal pleura, to which the visceral pleura was adherent, was found about the costochondral junction of the first rib. Another similar mass, but twice as large, was found just above the diaphragm, which filled the angle between the aorta and the vertebral column. Neither of these had a bony connection. The right pleural cavity was normal.

*Lungs:* There was congestion at the bases of both lungs with small, irregular, firm hemorrhagic areas, ranging in size from a few millimeters to two centimeters, more marked in the lower left lobe. The tracheobronchial and hila lymph nodes were not enlarged.

were relatively much larger than those normally found in the human joint. In the cat and the macaque the cruciate ligaments expanded to cover the entire surface of the tibial condyle and were better developed than in any of the other animals. The tree-climbing, limb-swinging habits of these animals would induce us to believe that the cruciate ligaments act as check ligaments against rotation and subluxation when the knee is flexed.

The relatively small size of the cruciate ligaments in man would lead us to suppose that they are vestigial and relatively unimportant in knee stability. Embryological studies would tend to confirm this, as the cruciate ligaments were part of the posterior capsule and became isolated within the joint as the femoral condyles increased in size posteriorly.

The menisci are proportionately much larger in the human knee joint than in any of the animals dissected. The best development of these fibrocartilages in the animals was seen in the chimpanzee which assumes a semi-erect posture in walking.

These menisci are even better developed in the human knee which bears weight in the fully extended position. The value of these structures can be determined from a study of their function. In the extended position they fill in the space around the condyles and deepen the articular surfaces of the tibial condyles, thus adding stability. By this accurate approximation of the articular surface, a film of synovial fluid is spread to lubricate the cartilaginous surfaces. They act as shock absorbers where sudden strain is transmitted to the hyaline cartilaginous surfaces. Being of fibrocartilaginous structure rather than true hyaline cartilage, they have more power of growth and healing when injured.

In the small animals with knees habitually flexed, the menisci were small and very narrow. The alligator showed well-developed menisci, but this animal is relatively heavy and has a fibula which articulates with the lateral surface of the femoral condyle.

These findings would cause us to feel that the menisci are very important structures for weight-bearing knees.

Since the menisci are of fibrocartilaginous tissue and will regenerate if the synovial attachment is left intact, it would seem desirable when meniscectomy is indicated to remove only the torn portion, leaving a rim of meniscus attached to the synovia.

removed, eroded bone was found beneath. The neck of the right femur was not explored. The left humerus, including the fibula graft, was removed. The graft was firmly united, but practically all of the fibula was surrounded by tumor. Three rustless-steel wires were noted *in situ* holding the humerofibula graft.

## MICROSCOPIC EXAMINATION

*Left pleura:* Section of a nodule from the left pleura revealed a diffuse, rich, compact, cellular tumor which appeared to be on the surface of the parietal pleura. The cells composing the tumor contained fairly uniform, oval to round, deeply stained nuclei with nucleoli. Some of the nuclei were vesicular and contained a reticulum, while in most of them the chromatin was finely granular and evenly distributed. In the less compact portions of the tumor, the nuclei were larger. A palely stained granular cytoplasm, small in amount and irregular in outline, was visible about many of the nuclei. Mitotic figures were common. Just beneath the pleura and in the tumor, considerable hemorrhage was noted. Connective-tissue septa, extending down into the tumor from the pleura, were observed. Blood vessels were numerous.

Section of the growth along the side of the aorta revealed the same histological findings as already described, except that more hemorrhage and vascular stroma were noted. In one portion the hemorrhage seemed to be of considerable age with organization already begun.

*Pancreas:* The sections taken from different portions of the gland showed only remnants of pancreatic tissue. These small portions of the gland that had been infiltrated by the neoplasm showed marked evidence of cytolysis. There was a striking resemblance between the cells com-

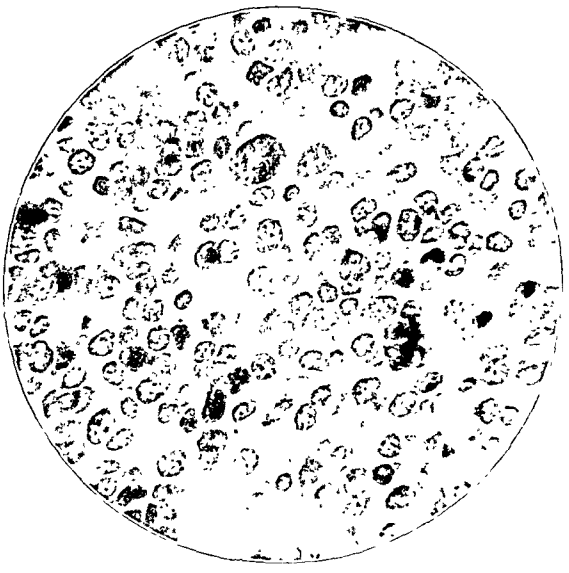


FIG. 9

Photomicrograph (oil immersion) of tumor of ilium, showing polyhedral cells. Note large, mononucleated cell.

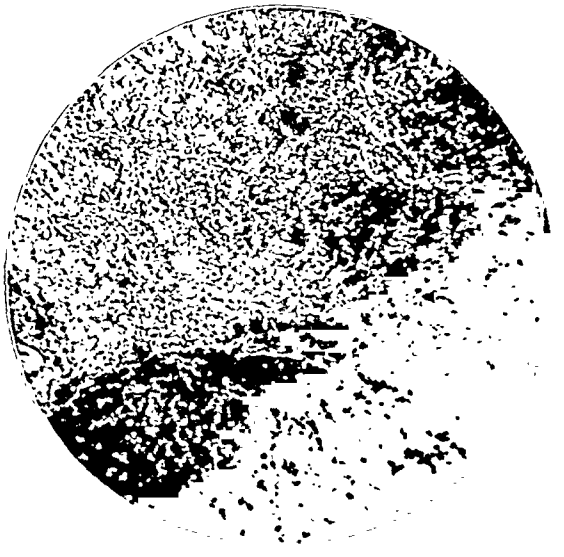


FIG. 10

Photomicrograph (low dry) showing the tumor infiltrating the kidney substance. The split in the section is on a plane with the capsule.

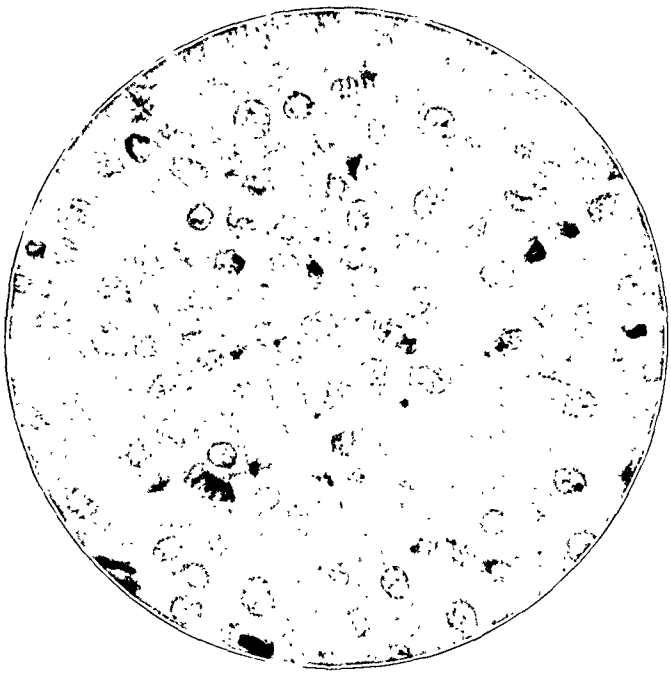


FIG. 7

Photomicrograph (oil immersion) showing small round cells with scanty, faintly stained cytoplasm. The nuclei are vesicular and eccentrically located. Note the occasional nucleolus and mitotic figure.

*Heart:* The heart was smaller than normal, and the muscle was very pale. The pericardial cavity contained a normal amount of fluid.

*Kidneys:* The right kidney was normal. In the left kidney there were two metastatic tumor masses, about one centimeter in diameter, well demarcated, slightly elevated above the surface,—one was hemorrhagic; the other resembled a fibroma, except that it was softer. The capsule was adherent at these points. The pelves of the kidneys were normal.

*Spleen:* The spleen was moderately firm; the capsule was smooth, the cut surface being moist, less red than normal, and without visible tumor nodules.

*Stomach and intestines:* These organs were not involved.

*Suprarenal glands:* The left suprarenal gland was riddled by hemorrhagic, moderately firm, oval nodules; the cut surface was dark red, smooth, and moist. Scarcely any gland tissue was visible. The right suprarenal gland was normal.

*Liver:* The liver was much smaller than normal and there were no metastases.

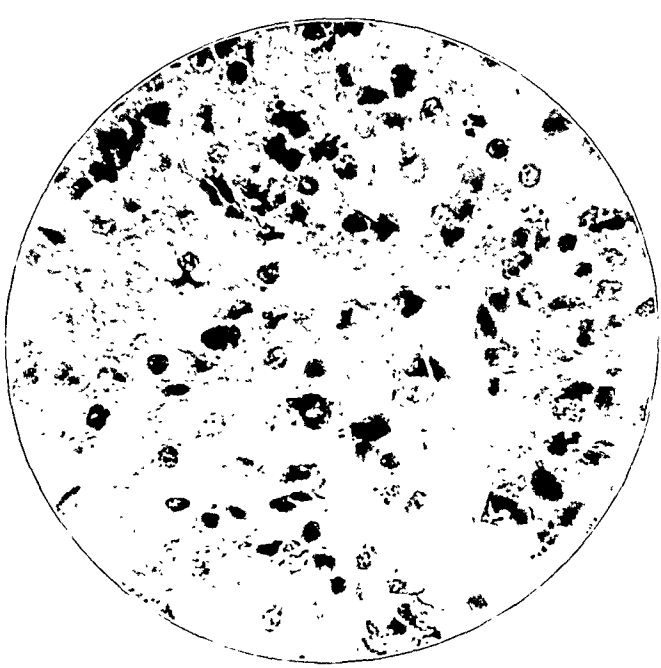


FIG. 8

Photomicrograph (oil immersion) of tumor cells in the medullary cavity distal to the pathological fracture.

*Gall bladder and appendix:* These organs were normal.

*Pancreas:* Most of the body and of the tail was almost completely destroyed by tumor nodules which were semi-fluctuant, oval, and hemorrhagic in appearance. Upon the cut surface the centers were necrotic and surrounded by a homogeneous, smooth, dark-red, hemorrhagic tissue.

*Mesenteric lymph nodes:* The mesenteric lymph nodes were normal in appearance.

*Ovaries:* Practically all that remained was fibrous-like tissue, a by-product of irradiation.

*Bladder:* The bladder contained four ounces of urine.

*Skeleton:* A large tumor mass was found internal to the left sacro-iliac joint and the ilium. When this mass was

in this case, but the fact that there are patients alive six, eight, ten, and more years following radical surgical treatment with and without irradiation and Coley's toxin argues strongly against this theory. It is almost inconceivable to us that the tumor in the left suprarenal gland could have been the primary focus in this patient for such a long time and yet have remained so small. The size of this suprarenal tumor argues directly and positively against one of the cardinal principles of malignancy in that it did remain small. The microscopic sections showed marked cellular hyperplasia in the tumor and no tumor-cell necrosis. We are, therefore, of the opinion that the primary focus was in the left humerus.

The long duration of symptoms, which is so often the case before any definite diagnosis can be made, argues against Ewing's tumor as having its primary origin in some organ apart from the skeletal system.

Considerable criticism has been expressed regarding the incompleteness of previously reported necropsies, particularly with reference to the suprarenal glands and the bronchi. These organs were especially carefully investigated in this case as the foregoing report bears out.

More carefully made necropsy studies are urgently needed where this tumor is concerned, which perhaps will clarify some of the controversial points that now exist.

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posing the islands of Langerhans and the tumor cells except for the pyknosis so marked in the island nuclei. Mononucleated and polynucleated giant cells and mitotic figures were quite common.

*Left kidney:* Sections of both tumor masses in the left kidney revealed the kidney tissue to have been destroyed by the infiltrating tumor, the histological picture being identical to that seen in the pancreas. The tumor appeared to have begun in or about the capsule of the kidney, resulting in a piling-up of cells outside of the capsule and an infiltration of the kidney parenchyma to a considerable depth. There was granular degeneration of the tubular epithelium, and some tubules were devoid of epithelium.

*Suprarenal glands:* Section of the two nodules in the left suprarenal gland revealed a dense, compact, cellular tumor of the same cell histology as those already described. There was a rich vascular stroma, and much hemorrhage was noted in places. No gland structure was discernable. Mitotic figures were quite numerous. The right suprarenal gland had a normal histology.

*Iliosacral tumor:* Section revealed dense, compact, cellular tumor growth, the nuclei of which varied in size, and many of them appeared as mononucleated and polynucleated giant cells. Mitotic figures were more numerous than in previously described sections. The tumor was infiltrating the adjacent muscle.

*Heart:* Section of the heart showed atrophic changes in the muscle.

*Lungs:* Small patches of cellular infiltration, particularly about some of the bronchioles and air vesicles, were noted. Much mucus was present in the lumen. No tumor cells were found.

*Liver:* Only degenerative changes, with some fatty infiltration, were noted.

*Spleen:* There was moderate congestion, and focal collections of phagocytes, containing blood pigment, were observed. Very few lymphocytes were seen, and these were in the perivascular tissues. Plasma cells were numerous.

*Ovaries:* The ovaries were little more than masses of fibrous tissue with numerous thick-walled blood vessels. There was no evidence of glandular function.

## COMMENTS

The fact that the patient stated that she had rheumatic-like pain in the left arm in the fall of 1931 and again in July 1933, coupled with an unquestionable bone lesion at the time of the pathological fracture in August 1933 as revealed by the roentgenogram taken at that time, justifies the assumption that all symptoms complained of were probably the results of the Ewing's sarcoma. Intermittent attacks of pain in the upper third of the left arm and fever, therefore, were experienced for more than three years before we saw the patient. These intermittent attacks are common in patients with this tumor. She lived about five and a half years after the onset of the first symptoms and about twenty-eight months after admission to this Clinic.

Tumors that have been confused with Ewing's tumor with primary foci in the bronchi and in the adrenals have been reported. Careful examination of the bronchi was made in this case without finding any evidence of a tumor. Moreover, examination of the lungs proper was negative for neoplastic nodules. On the other hand, the left suprarenal gland was practically destroyed by the neoplasm as was also the pancreas. Colville and Willis have expressed their opinion that adrenal neuroblastoma will prove to be the primary growth in many cases reported as Ewing's tumor. One cannot state that the growth in the suprarenal gland was not primary

sharp, and radiating down the outer aspect of the right arm as far as the insertion of the deltoid and to the upper part of the lateral wall of the right side of the thorax. The pain was not relieved by infra-red radiation or by diathermy.

The patient was a well-developed, well-nourished male; there were no gross malformations nor deformities. The heart and lungs were essentially negative to percussion and to auscultation. Except for the findings in the region of the right shoulder, the physical examination was essentially negative. There was no atrophy of the tissues about the right shoulder girdle. There was some thickening of the tissues over the region of the greater tuberosity of the right humerus, with tenderness to deep palpation. No limitation of motion of the right shoulder nor weakness of the right upper extremity were noted.

Roentgenographic examination of the right-shoulder region on May 26, 1936, revealed a calcific deposit overlying the greater tuberosity of the right humerus (Fig. 1).

The patient was given a series of infra-red and diathermy treatments to the right-shoulder region, without relief of the pain. On July 14, 1936, under local novocain anaesthesia in the region of the calcific deposit, an attempt was made to aspirate the mass. It was punctured many times in fanwise fashion, but nothing could be aspirated. On withdrawing the needle, it was noted that the lumen was filled with an amorphous, calcified material. Following this, the patient was again given diathermy to the shoulder, supplemented by iron cacodylate intravenously. Slight relief was obtained for about a week, but gradually the pain returned and became so severe that the patient could not lie on the affected side. On September 22, 1936, a second aspiration was performed with the same result of aspiration but without relief of the pain. At the time of the aspiration, it was noted that the patient held the arm almost fixed against the side of the body and that abduction of the arm was limited. On October 14, 1936, the patient was operated upon for a subdeltoid bursitis. A one-inch incision was made in the deltoid muscle, the fibers were separated, and the subdeltoid bursa was exposed.

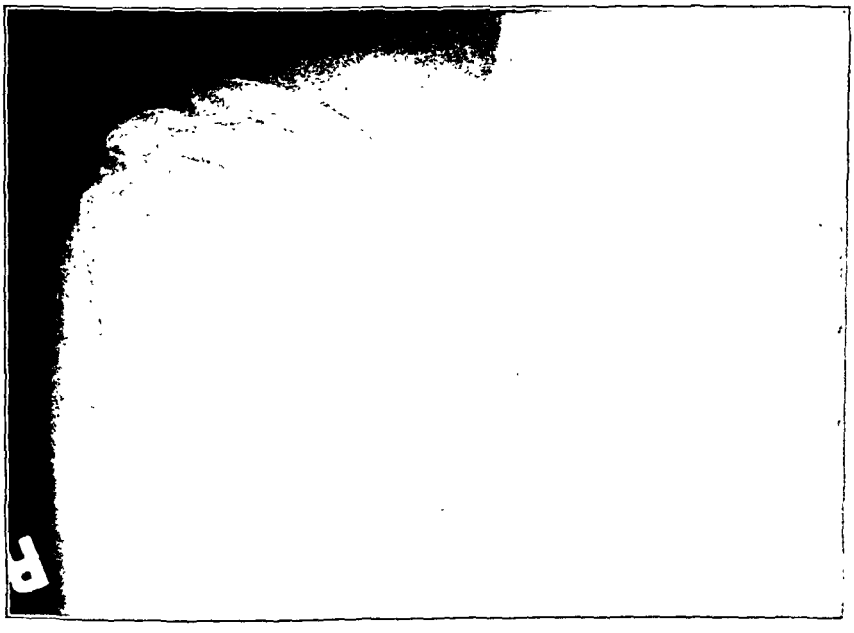


FIG. 2

Roentgenogram taken December 8, 1936, following the surgical removal of the bursa. There is still present a small amount of the calcific deposit. The pathology in the apical region is more clearly demonstrated.

# SUPERIOR PULMONARY SULCUS TUMOR SIMULATING SUBACROMIAL BURSITIS

BY LOUIS NATHANSON, M.D., AND LEW A. HOCHBERG, M.D.,
BROOKLYN, NEW YORK,
AND ROBERT PERLMAN, M.D., CINCINNATI, OHIO

Shoulder pain may be due to a local process or it may be referred from a lesion elsewhere in the body. It may be part of a symptom complex such as is frequently encountered in lesions of the upper spine, the cardiovascular system, and the pulmonary and mediastinal structures. Pain about the shoulder region requires an investigation of these structures before one can be sure that the cause is not outside the shoulder girdle. It is unusual to have sufficient local pathology to account for a patient's symptoms and then to find that the pain is due to a lesion elsewhere. The patient whose case is presented in this communication had both a calcified subacromial bursa and a superior pulmonary sulcus tumor. In the early stages of the patient's disease, it was believed that the subacromial bursa accounted for the pain, but, as the symptom complex progressed and other physical signs developed, the patient was found to have a neoplasm of the apex of the lung. It is because of the unusual combination of local and neighboring lesions, either of which could account for the patient's early symptoms, that the following case is presented.




FIG. 1

Roentgenogram of the upper half of the right chest and shoulder, taken May 26, 1936. There is a flat calcified plaque in the subacromial region. There is also a suspicious density in the supraclavicular region.

## CASE REPORT

N. S., a white male, aged sixty-two years, was first seen on May 26, 1936. At that time he complained of pain in the right-shoulder region of four months' duration. There was no history of trauma or of infection either locally or systemically preceding the onset of the shoulder pain. The pain was more or less constant,

FIG. 6

Roentgenogram taken July 13, 1937. There is further progression of the apical and mediastinal pathology. In addition, there is evidence of a pericardial effusion.




FIG. 5

Roentgenogram taken May 24, 1937. The tumefaction has increased in size. There is increased mediastinal involvement.

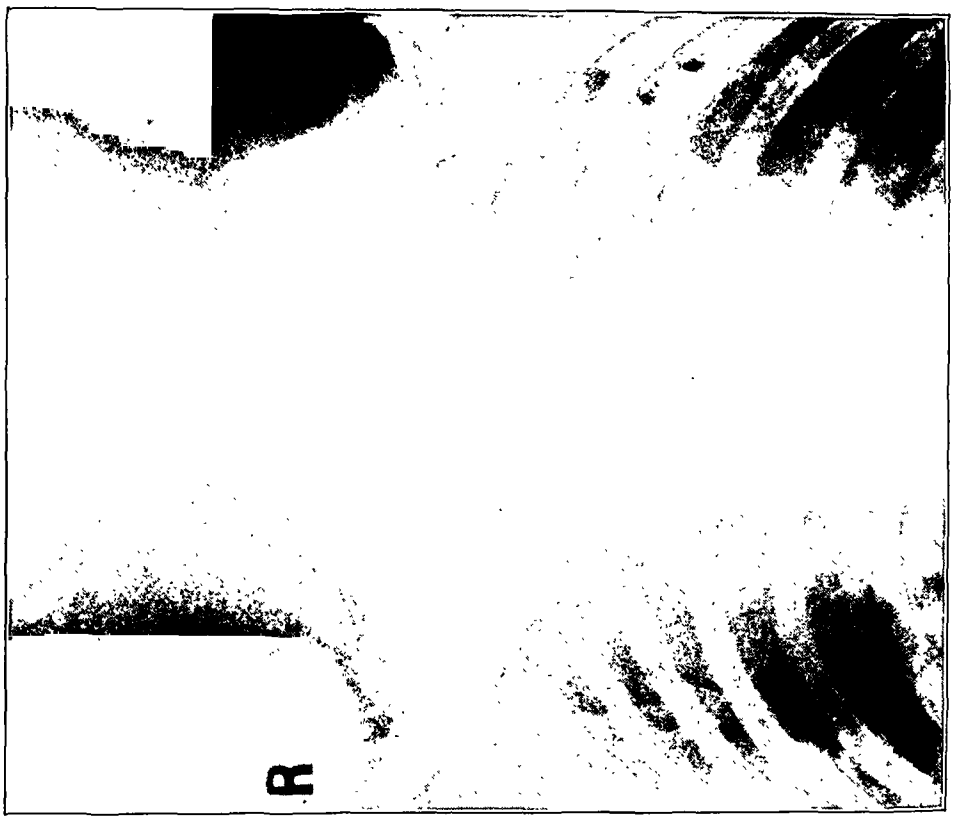



FIG. 4

Bucky study taken March 19, 1937. There is demonstrable, in addition to the findings shown in Fig. 3, a local erosion of the first rib and a periosteal reaction along the inferior border of the second rib. Also note that the trachea is displaced to the contralateral side.

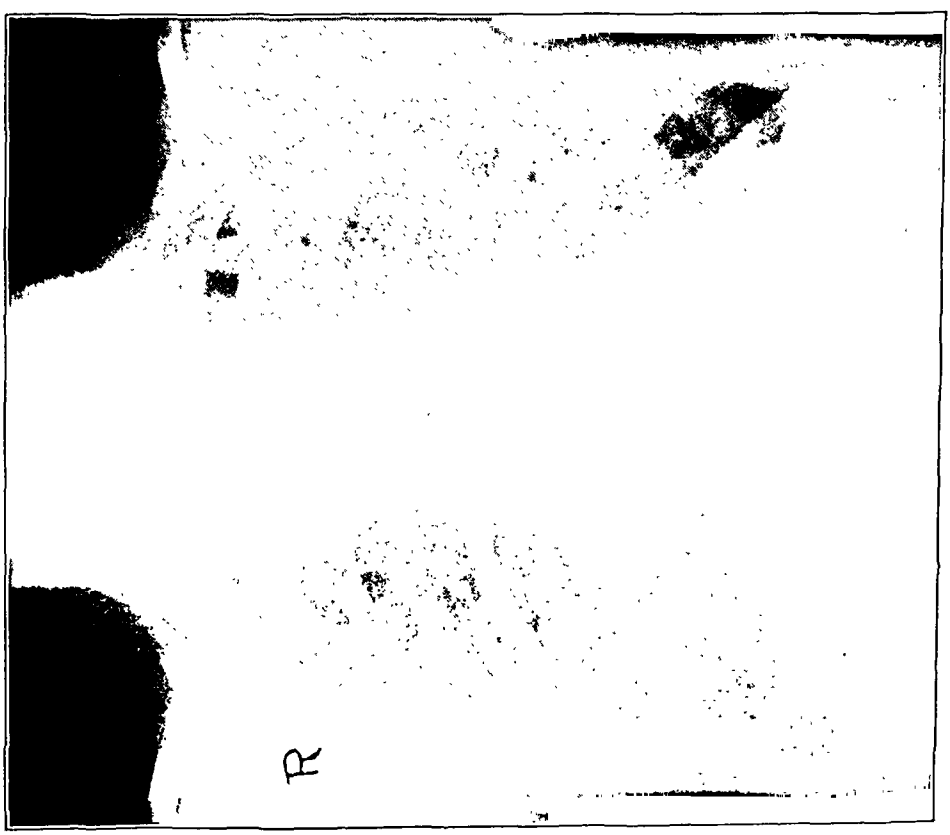



FIG. 3

Roentgenogram taken March 19, 1937. There is extension of the opacity (tumor) to the mediastinum.

# SPINAL FIXATION

## A Method of Bending the Graft

BY GAWAD HAMADA, M.R.C.S., ALEXANDRIA, EGYPT
*From the Government Hospital, Alexandria*

The conservative methods of fixation of the spine require a long period of recumbency, which is trying to the patient, and the end results are not as good as those obtained by the operative methods. It has been the experience of many writers that the percentage of solid union and healing of the vertebrae is greater and the mortality is less when operative measures are employed than when the treatment is conservative.

The aim of any operative method of internal fixation of the spine is to shorten the period of recumbency and external immobilization. The procedures most frequently employed are those of Albee and Hibbs and what may be termed the "modified method". The author wishes to discuss the relative merits of these three techniques and to present a method of bending the tibial graft, which he has used with success.

### THE ALBEE OPERATION

The author feels that this method has the following disadvantages:

1. The graft is too superficial.
2. The entire surface of the graft is not apposed to the vertebrae; it bridges the spines.
3. The vascularization of the graft is not as good as that afforded by the Hibbs or modified methods.
4. The graft is away from the center of motion of the vertebrae and is, therefore, liable to tension and resultant fracture.

### THE HIBBS OPERATION

This method presents the following difficulties:

1. The operation is long, tedious, and not without risk.
2. If the operation is not thoroughly and painstakingly carried out, it usually results in failure.
3. If the operation fails, there is not much possibility of performing another.
4. The cutting of the interspinous ligaments tends to weaken the natural support of the vertebral column, should the operation be unsuccessful.
5. If sepsis should develop, there is great danger of sequestration of the sections of the vertebrae which have been turned up and down.

### THE MODIFIED METHOD

Although this technique has been fully described by Sir William I. deC. Wheeler [1], the author feels that it has not received the attention which it deserves, and, therefore, a brief description is included.

The bursa was opened and within the tendon of the supraspinatus a whitish area was found. The tendon was incised in the line of its fibers, and the whitish mass, composed of amorphous and calcified material, was curetted. Following the operation, the right shoulder was maintained in abduction and external rotation with some relief of the pain. The patient continued to improve for a while during his stay in a warmer climate. However, during the latter part of his sojourn the pain returned and was more severe than ever before. In addition, the pain now radiated down the inner aspect of the arm and forearm as far as the wrist. At this time, the patient began to lose weight and strength. On March 19, 1937, it was noted that the patient had a Horner's syndrome and atrophy of the muscles of the hypothenar eminence. Roentgenographic examination of the chest at this time revealed an area of opacity at the right apical region (Figs. 3 and 4), upon which basis, together with the physical findings, a diagnosis of superior pulmonary sulcus tumor was made. The patient's course from this time was progressively downhill. The tumor increased in size and extended to the mediastinum (Fig. 5). The pain became increasingly more severe and was barely relieved by large doses of opiates. Before death, the patient presented a picture of extreme cachexia with a superimposed pericardial effusion (Fig. 6). The patient became comatose and died on July 22, 1937.

The case described illustrates the necessity of examining the thorax in cases of persistent shoulder pain even though local pathology may be present. This is particularly true in those cases in which the patient's symptoms are not alleviated by the usual methods. It is our impression that calcification about the shoulder, particularly in elderly subjects, is not uncommonly found in routine roentgenographic examinations of that region. In many instances, these are asymptomatic. Familiarity with chest pathology is essential, since a lesion of the type reported herein may readily be overlooked by one not experienced in the interpretation of roentgenograms of the chest.

Pancoast, who first presented the subject of superior pulmonary sulcus tumor in 1924, in a further study in 1932 stated: "The name of 'superior pulmonary sulcus tumor' has been given to it because this term implies its approximate location and a lack of origin from the lung, pleura, ribs or mediastinum." In 1934, Jacox declared: "Opportunity to examine autopsy material from a case of this sort has convinced me that, at least in this instance, the tumor arose from the mucosa of the terminal bronchioles in the apex of the lung, and that the name 'primary carcinoma of the pulmonary apex' might be appropriate." Opinion varies as to the origin of these tumors. There have been too few cases reported to date to warrant any definite conclusions. Suffice it to say that they are malignant growths located in the apical pulmonary regions.

In the early manifestations of the disease the symptoms are more or less confined to the region of the apex of the lung and the shoulder. In the latter stages, the syndrome is characterized by symptoms due to pressure on the contiguous structures. By pressure on the brachial plexus and the ribs, the tumor causes pain, tenderness, and hyperaesthesia about the shoulder and the axillary regions, as well as at the other sites of distribution of the nerve fibers impinged upon. Atrophy of the muscles of the arm and hand is a late manifestation of brachial-plexus involvement. A Horner's syndrome frequently develops, due to sympathetic-

nerve involvement, and erosion of the first and second ribs manifests itself with the gradual expansion of the neoplasm in the region of the apex of the lung.

This syndrome is suggestive of superior pulmonary sulcus tumor. Such symptoms, together with a roentgenographically demonstrable apical tumefaction, are pathognomonic of the disease. Fried reported a case in which the first impression was that the patient had syringomyelia. Tobias described an apicocostovertebral-pain syndrome in apical tumors with the development of radicular pain and sympathetic-nerve involvement. Clinically, the syndrome may occasionally be altered by additional symptoms or by a variation in the severity of the local manifestations. In such instances, the primary cause is readily overlooked, as in the case herein presented.

## CONCLUSIONS

In any case of persistent shoulder pain where active and thorough local treatment fails to alleviate symptoms, an investigation of surrounding structures should be made. Many roentgenological clinics routinely fluoroscope the chest in all cases of shoulder pain and, when suggestive pathology is found, roentgenographic studies are made of the chest. The finding of a calcified bursa in an elderly individual may at times mask the true cause of shoulder pain. A calcified bursa is not infrequently asymptomatic.

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# PRIMARY ENDOTHELIOMYELOMA (EWING'S TUMOR) OF THE SACRUM

BY E. A. BRAV, M.D., F.A.C.S., AND A. M. RECHTMAN, M.D., F.A.C.S.,
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Inasmuch as no similar case was found in a review of the literature, the authors wish to record a case of primary endotheliomyeloma (Ewing's tumor) of the sacrum, together with the findings at biopsy and at post-mortem examination. Ewing's tumor is most prevalent in the shafts of the long bones such as the humerus, the tibia, and the femur, but it also occurs in the ilium, the vertebrae, the skull, the ribs, the scapulae, and the bones of the feet. Primary tumors of the pelvic bones have been described most frequently in the ilium adjacent to the sacro-iliac joint.

## CASE REPORT

J. G., a pale and poorly nourished girl of ten years, was apparently well until a few months previous to April 9, 1935, when she was first examined. There was no history of injury. She complained of pain at the base of the spine, lasting about two days and recurring at varying intervals. Her weight had been constant. On examination, there was slight tenderness to pressure in the upper sacral area. The spinal motions were normal. Roentgenographic examination on April 10, 1935, revealed only a spina bifida occulta of the first sacral segment (*Figs. 1 and 2*).

The patient was reexamined three months later. The intermittent pain in the lower back had persisted and she now complained of pain in the region of the right hip, radiating to the outer aspect of the calf. The child was admitted to the Jewish Hospital on July 22, 1935. The temperature on admission was 100.6 degrees and the pulse was 110.



FIG. 1



FIG. 2

Roentgenograms, taken on April 10, 1935, were negative except for a spina bifida occulta of the first sacral segment. There was a possibility of slight decalcification in the right sacral wing.

The gait was awkward and guarded, and the trunk listed slightly to the right. There was some tenderness to pressure in the regions of the posterior superior iliac spines. Flexion of the spine was possible to half the normal amount, but occurred with a list of the trunk to the right. Hyperextension of the spine was unrestricted, but caused discomfort referred to the right calf. Neurological examination was negative except for abortive nystagmus and exaggerated leg reflexes.

The patient left the Hospital on July 27, 1935, and visited the Orthopaedic Clinic ten days later. Her symptoms had persisted and she had lost three pounds in weight. Examination revealed tenderness on pressure to the right of the middle of the sacrum and the presence of a hard, slightly tender swelling of the tissues in this region. Roentgenograms (Figs. 3 and 4), taken on August 6, 1935, showed an area of absorption in the right side of the body of the sacrum medial to the sacro-iliac joint. There was some rarefaction of the lower portion of the right side of the sacrum and a bulging and thinning of the cortex in this region. The sacro-iliac joint and the ilium were not involved. There was no sclerosis of bone. The lateral view showed definite evidence of destruction of the second sacral segment and a suggestion of destructive changes in the other segments. The conditions considered in the diagnosis were giant-cell tumor of the sacrum, osteolytic sarcoma, and osteomyelitis.

The child was readmitted to the Hospital and received three roentgen-ray treatments of 160 roentgen units each. The result was a decrease in pain in the back and the leg, and the tenderness and swelling of the sacrum disappeared entirely. Motions of the spine became free and painless. Roentgenographic examination of the chest gave negative results and the blood analysis revealed no anaemia. Because of the rapid subsidence of the swelling and the patient's clinical improvement after the roentgen-ray treatments, an endotheliomyeloma (Ewing's tumor) was suspected. Roentgenographic examination on August 24, 1935, showed an increasing destruction involving particularly the second sacral segment. An area of sclerosis surrounded the region of absorption. This factor also favored a diagnosis of endotheliomyeloma. Because of the necessity of using large doses of roentgen-ray therapy, a biopsy was considered advisable.

On August 27, 1935, the posterior surface of the sacrum was exposed through a small longitudinal incision. In stripping the thickened soft tissues from the bone, the cortex was easily fractured and the instrument entered a cavity in the sacrum. The cancellous bone in this region had been completely absorbed and the cavity was partly



FIG. 3 FIG. 4

Roentgenograms, taken on August 6, 1935, showed an area of absorption and a bulging and thinning of the cortex over the lower two-thirds of the sacrum on the right side. The sacro-iliac joint and the ilium appeared normal. There was no bony sclerosis. The lateral view showed absorption, compression, and cortical irregularity, most marked in the second sacral segment.

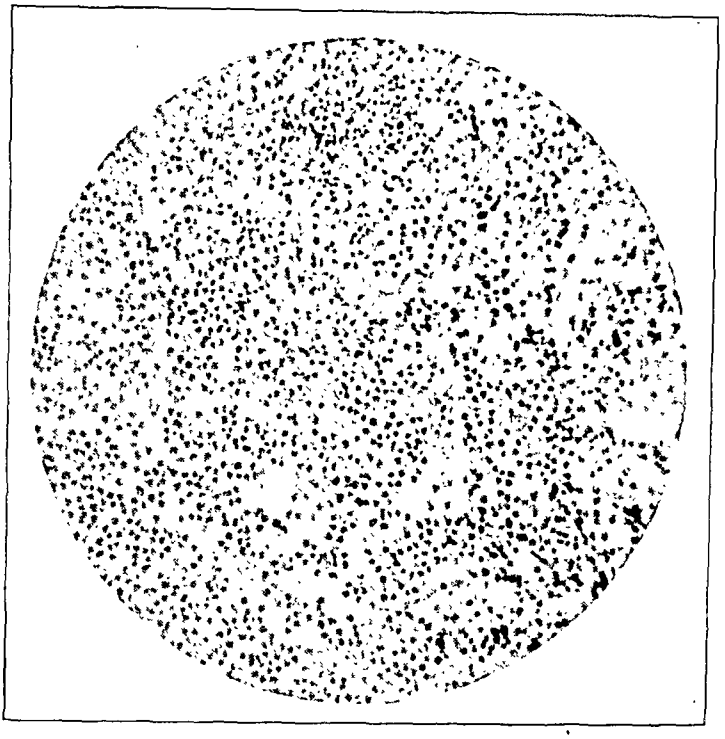


FIG. 5

Photomicrograph (× 120) showing closely packed cells with a large amount of intercellular stroma.

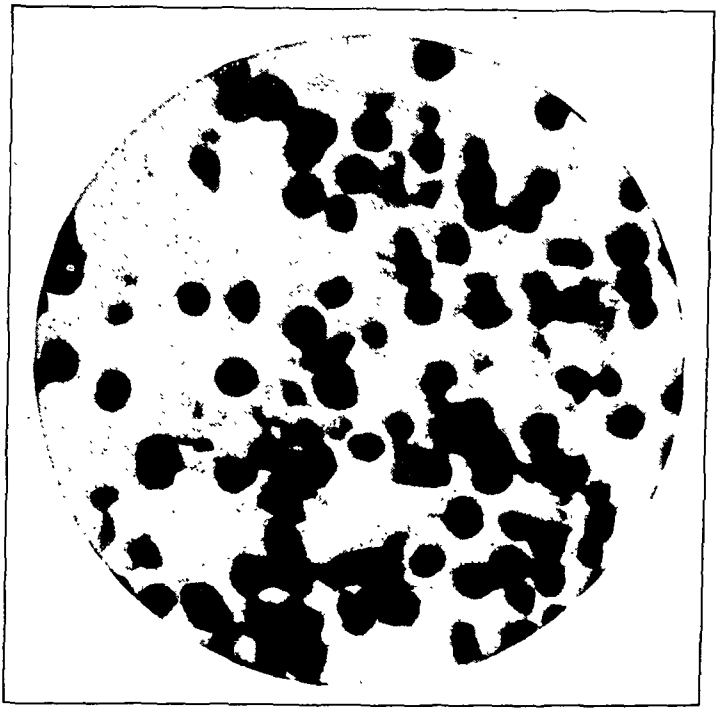


FIG. 6

Photomicrograph (× 510) showing the polyhedral cells with small, deeply staining, round or oval nuclei and scanty stainless cytoplasm. No multinucleated cells are seen.

filled with a grayish, gelatinoid material, some areas of which were of cartilaginous consistency. Specimens were removed for study.

The biopsy specimens (Figs. 5 and 6) were examined by Dr. Samuel Levine, and his examination revealed "a section of tissue with a large number of abnormal cells appearing in sheets and having a clear cytoplasm. The cells are polyhedral in shape and possess sharply defined borders. The nuclei are small, centrally located, and moderately hyperchromatic. The stroma is rich in connective tissue. Many of the nuclei contain nucleoli. No mitotic figures are observed. The tissue possesses a poor blood supply. The neoplastic cells have a haphazard arrangement and resemble endotheliomatous cells. Some of the cells are seen lying freely within the bone lacunae. No abnormal osteoblasts are observed. Diagnosis: Endotheliomyeloma (Ewing's tumor)".

The patient received twenty additional roentgen-ray treatments, a total of 5000 roentgen units. She was also treated with Coley's toxins. Roentgenographic examination on September 20, 1935, and again on October 16, 1935 (Figs. 7 and 8), showed some increased density in the area of involvement, but a considerable amount of rarefaction remained. Clinically the child's condition appeared to be improved. The wound

healed readily, there was no pain, and the mass did not recur. The patient was discharged from the Hospital on September 26, 1935.

On March 13, 1936, the child again entered the Hospital, complaining of weakness and pain in the legs, loss of appetite, and vomiting. A marked thickening was present over the posterior surface of the sacrum and in the lumbar region to the right of the mid-line. The abdomen was moderately distended. Enlargement of the veins about the umbilicus was noted. A firm, somewhat tender, fixed mass was palpable to the right of the umbilicus. An excess of fluid was present in the peritoneal cavity. Roentgenographic examination (Figs. 9 and 10) on March 2, 1936, showed increased bone formation in the sacrum, but in the lateral view a progressive destruction of the sacral segments was seen. The ilium was not involved. An intravenous urogram gave negative results. The leukocyte count was 20,400 and the polymorphonuclear count was 87



FIG. 7 FIG. 8

Roentgenograms, taken on October 16, 1935, showed an increased density in the right sacral wing, but considerable rarefaction was still present. The lateral view showed that the destruction had progressed. There was compression of all the sacral segments.

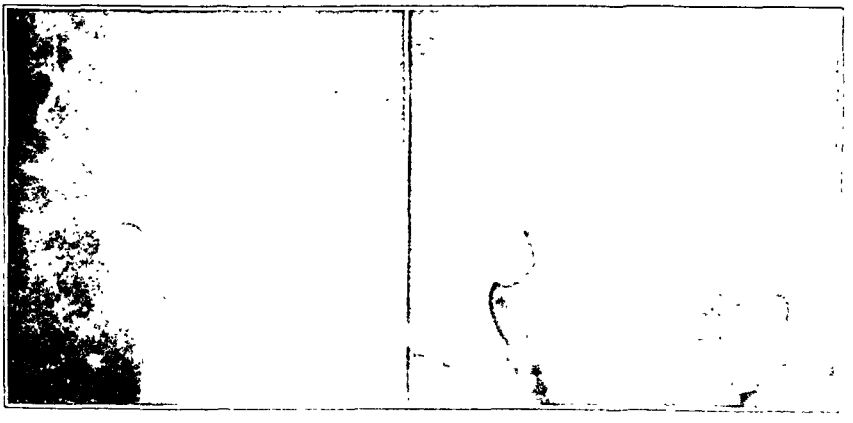


FIG. 9 FIG. 10

Roentgenograms, taken on March 2, 1936, in the anteroposterior view showed increased bone formation in the involved area of the sacrum with generalized surrounding sclerosis. The lateral view revealed greater destruction than was previously present. The ilium showed no involvement.

per cent. The patient became progressively weaker. She had attacks of nausea and vomiting, but complained of only occasional pain in the leg. The abdominal enlargement increased and the superficial veins became progressively distended. The mass in the right upper abdomen became very prominent. The patient began to complain of headache and abdominal pain. She died on May 30, 1936, during a convulsive attack.

*Pertinent Post-Mortem Findings*

The report of the post-mortem examination by Dr. David Fishback was as follows: "The cervical and axillary glands are enlarged. The pericardium contains an excess of light amber fluid. The left pleura contains 600 cubic centimeters of dark-brown fluid and the right a moderate quantity of grayish-white, blood-tinged fluid. Both lungs show partial atelectasis and there are small hemorrhagic infarcts in the lungs and the pleura. The inferior vena cava and the thoracic duct are surrounded by many fine, grayish lymph glands and are markedly compressed.

"The peritoneal cavity contains 200 cubic centimeters of grayish-white chylous fluid. The stomach and intestines are pushed forward by markedly enlarged retroperitoneal glands and by a firm grayish-white malignant mass, the size of a grapefruit, in the region of the left kidney and immediately below the spleen. The liver and the spleen are easily separated from this mass, but it is adherent to the left kidney, the pancreas, and the transverse and splenic flexures of the colon. The mesenteric lymph nodes are all markedly enlarged. Both kidneys are surrounded by a firm, grayish, malignant tissue and the adrenals are compressed. The pancreas is grayish-white, firm, and almost twice its normal size.

"The right portion of the sacrum is markedly softened and cuts readily. There is destruction of the sacrum adjacent to the right sacro-iliac joint. Within the sacrum there is a soft, dark-red tumor mass. A similar type of tumor tissue is also found in the right side of the fourth and fifth lumbar vertebrae. Apparently, there has been a direct extension of the tumor mass to the surrounding tissues and to the retroperitoneal glands. There is a reddish area of softened bone, apparently malignant, one by three centimeters, in the petrous portion of the right temporal bone.

"Histological examination of the tissue from the sacrum shows numerous polygonal cells having sharply defined borders with a small amount of clear cytoplasm and centrally located darkly staining nuclei. The abnormal cells appear in sheets. The cells are typical of Ewing's tumor. The tissue surrounding the adrenals shows a few muscle fibers separated by a diffusely infiltrating Ewing's tumor. Diagnosis: Endotheliomyeloma (Ewing's tumor)".

# HODGKIN'S DISEASE OF THE BONES

BY HERMAN S. LIEBERMAN, M.D., NEW YORK, N. Y.

In recent years the literature has contained an increasing number of reports of cases of lymphogranulomatosis in which the classical findings of lymph-gland involvement, as first described by Hodgkin and the early writers, have been overshadowed by other manifestations. It is now becoming more evident that Hodgkin's disease may manifest itself in many different and bizarre ways.[1,2,3] Frequently the pathological changes may be first apparent in the osseous system, as illustrated in the following case presentation.

## CASE REPORT

M. H., male, aged thirty-nine years, married, a janitor, complained of pain in the lower back. This condition had first been noted on May 20, 1936, immediately following a strain produced by carrying a heavy iron stove on the back down five flights of stairs. The patient applied home remedies with no relief of symptoms, and sought medical aid about seven weeks after onset of pain. He was treated at this time by another physician who prescribed baking to the lower back. Roentgenograms of the lower lumbar and sacro-iliac spine taken during this interval were reported as negative.

Since the patient was not improving, he changed physicians and was seen by the author on August 14, 1936, about three months after the initial injury. The pain in the lower back during this time had become marked, and, in addition, the patient complained of abdominal discomfort, poor appetite, and loss of about twenty-five pounds.

Physical examination showed that the patient had apparently lost weight. There was a slight tilt of the trunk to the left with bilateral spasm of the erector spinae, more marked on the left. Restriction and painful motions of the lower back, especially on forward and lateral flexion, were noted.

Marked tenderness was present along the second, third, fourth, and fifth lumbar vertebrae and the left sacro-iliac area. Straight-leg raising on the left was painful with the pain localized to the lower back. Straight-leg raising on the right was negative. Bilateral flexion of the thigh resulted in pain in the lower back. Reflex responses were normal. There were no sensory disturbances. The prostate gland was apparently normal.

Diathermy, infra-red radiation, and strapping of the lower back were instituted. The patient stated that he felt much better and that his appetite was improved. He was fitted with a sacro-iliac corset and received physiotherapy for three and one-half weeks.

Despite the fact that the patient believed that he was improving, clinical examination failed to show any decrease in the spastic appearance of the back. Roentgenograms were, therefore, ordered and the report was as follows:

"The roentgenographic examination of the lumbosacral spine shows irregular rarefaction and compression of the left side of the body of the third lumbar vertebra, with visible bony callus formation, indicative of a recent fracture."

Because of the history of loss of weight and the unusual type of trauma, the author was suspicious of a pathological fracture as the result of a neoplasm. However, the roentgenologist doubted the possibility of a malignant growth because of the presence of the bony callus in the roentgenogram.

The patient was, therefore, placed in a plaster-of-Paris jacket with the spine flexed to the right.

There was no apparent change following this procedure. The patient continued to have gastric disturbances, although no further loss of weight occurred. He was then in-

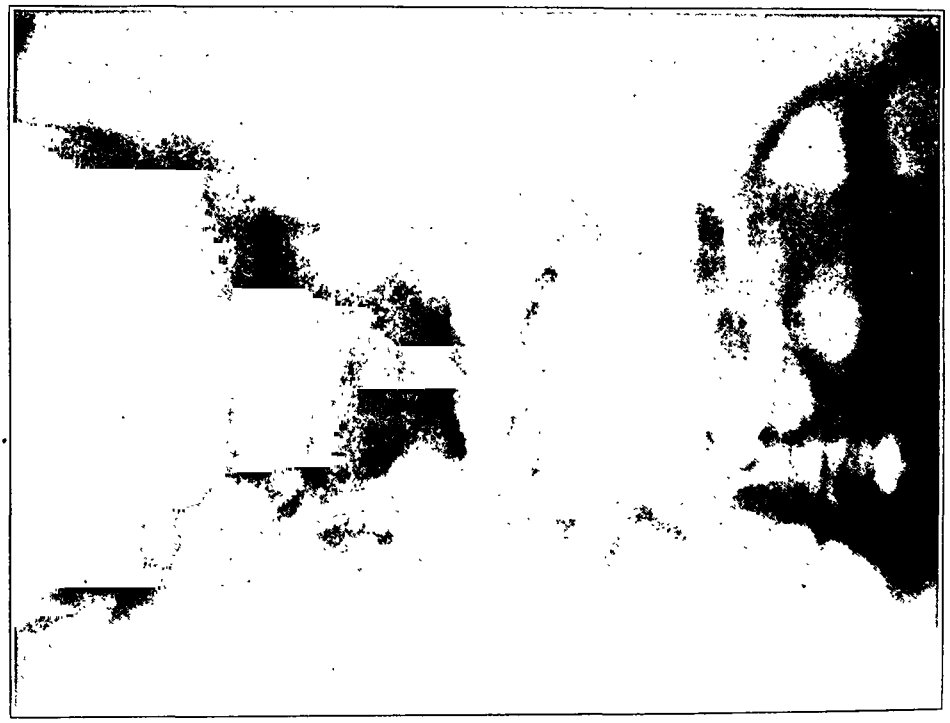


FIG. 1-B

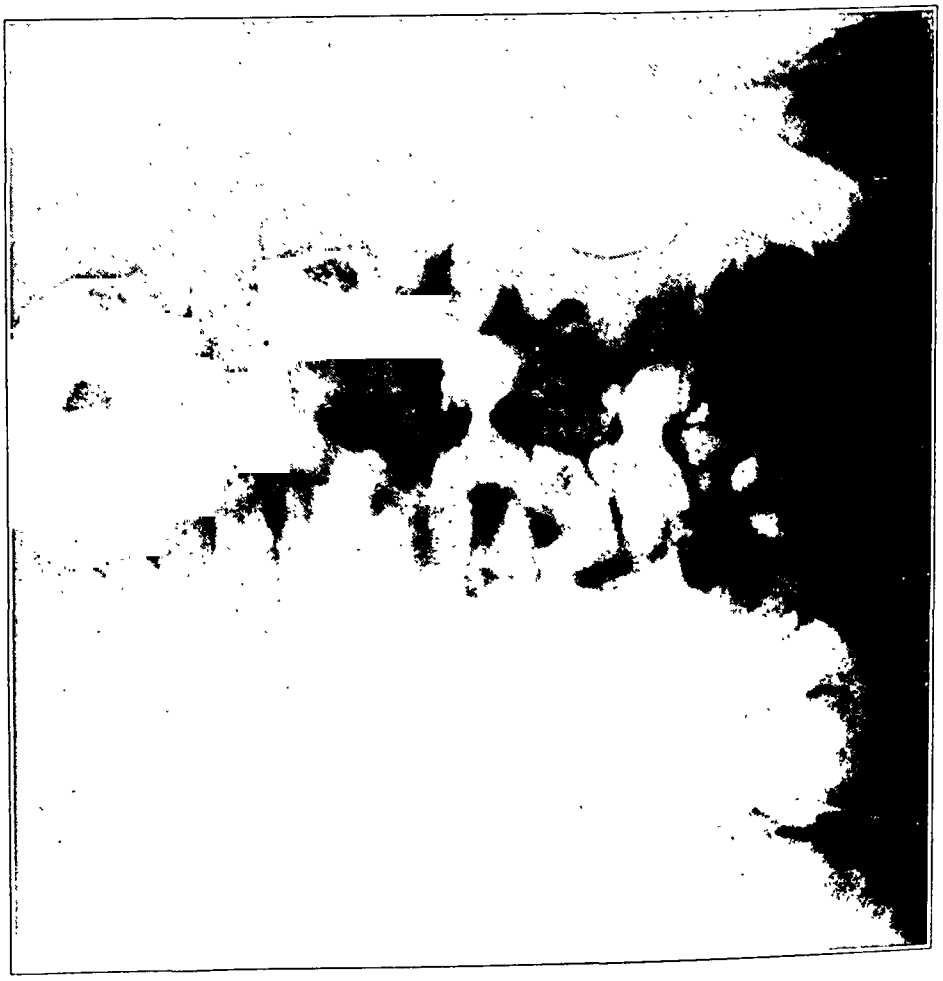


FIG. 1-A

Anteroposterior and lateral roentgenograms of the lumbar spine, showing destruction in the third lumbar vertebra.

structed to take his temperature several times during the day. This revealed a daily rise of 99.2 to 100.8 The possibility of either osteomyelitis or tuberculosis of the spine was then entertained.

After a month, during which no improvement had been noticed, the plaster-of-Paris jacket was removed, and examination showed spasm of the left erector spinae muscle. The area about the third lumbar vertebra on the left was very tender and painful. Tenderness was likewise present in the lower lumbar and sacro-iliac areas. There was a painful nodule palpable in the abdomen slightly above Poupart's ligament on the left. No evidence of any mass was felt in the abdomen, although some tenderness was present around the left side of the umbilicus and the left loin. Hypaesthesia was present on the left lower abdomen and the left lower extremity. There was slight exaggeration of both knee and ankle reflexes.

Measurements of the lower extremities were as follows:

| | |
|---|---|
| Right thigh | 17¾ inches |
| Left thigh | 15⅞ inches |
| Right calf | 12⅞ inches |
| Left calf | 12¼ inches |

Additional roentgenograms were then ordered, which showed an increase in the destructive process associated with luxation of the left inferior articulating process of the third lumbar vertebra with decrease of the evidence of callus formation previously reported.

The condition appeared to be a chronic infectious process, either osteomyelitis or tuberculosis. The patient was, therefore, hospitalized, and further study and treatments were continued with the collaboration of Dr. Leo Mayer.

On the morning prior to entering the hospital, the patient experienced sharp shooting pains in the left loin and the left lower extremity, following which he was unable to extend the left hip completely. Examination showed limitation of extension of the left hip to 160 degrees with some fullness in the left lower abdomen about the iliopsoas region. The patient was then placed on a convex frame and traction applied to the left lower extremity.

The blood count on the day of admission was as follows:

Red blood cells—3,680,000
Hemoglobin—60 per cent.
White blood count—14,400
Neutrophiles— 69 per cent.
Eosinophiles— 3 per cent.
Lymphocytes—28 per cent.

The Wassermann and Kahn tests were negative. The temperature varied between 98.9 and 100 degrees, and the pulse rate varied between 70 and 90 per minute. The differential tuberculin test showed slight reaction in the dilution of 1 to 10,000, but was negative in higher dilutions.

Further roentgenograms showed spreading of the destructive processes in the spine. The roentgenograms of the skull and the chest were negative.

*Diagnosis:* Neoplasm of the spine (hemangioma?).

Showing no improvement, the patient was then taken to the operating room for biopsy of the left inguinal glands.

The operative procedure performed on October 20, 1936, two weeks after admission, was as follows. A three-inch incision was made in the left groin. A mass of enlarged lymph nodes was found and three of them were removed. When split longitudinally, their gross appearance showed no particular abnormality. While frozen sections were being made, the incision was deepened through Poupart's ligament, exposing the psoas iliacus muscle. The fibers were separated bluntly until the posterior surface of the muscle was reached. No abscess or tumor mass could be demonstrated. The muscle fibers were spastic and gave the impression of a swelling which disappeared as the muscle fibers were retracted. The report of the frozen section was negative for tumor. The incision was closed with a subcutaneous stitch and dermol for the skin.

Pathological examination of the specimen, of which several sections were taken, was as follows:

*Gross:* "Specimen consists of a group of inguinal lymph nodes which are discrete, slightly enlarged, and on section present a yellowish-brown appearance."

*Microscopic:* "Serial sections of the incised lymph nodes show only chronic non-specific inflammation with some fibrosis, which probably has no relation to the lesion in the spine."

*Diagnosis:* "Chronic non-specific lymphadenitis. No evidence of malignancy."

No definite diagnosis was possible even after two weeks of study and following biopsy of the glands.

It is of interest to bear in mind the absence of any pathological findings within the iliopsoas muscle, except for the slight spasticity present.

On October 27, 1936, an exploratory operation was performed on the spine. A four-inch mid-line incision was made vertically, with its center corresponding to the spinous processes of the third lumbar vertebra. The spinous processes and the laminae of the second, third, and fourth lumbar vertebrae were exposed on the left side only. By strong retraction it was possible to expose the lateral processes of the second and third lumbar vertebrae. The lateral process of the second was removed first. Then the dissection was continued downward toward the third. During this dissection, an area of abnormal tissue was exposed. This was deep yellow in color, had the consistency of a thick custard, and had invaded the lateral process and the lamina of the third lumbar vertebra. About a thimbleful of this tissue was removed, together with the surrounding bone. A frozen section was taken at once, which showed no definite tumor cells. Further exploration failed to reveal the presence of any pus. The wound was closed in layers, using dermol for the skin.

Pathological examination of the specimen, of which a number of representative sections were taken, was as follows:

*Gross:* "Specimen consists of a number of soft, friable, yellowish, irregular fragments of soft tissue, about one centimeter in diameter. A few of the fragments include thin spicules of bone."

*Microscopic:* "Sections show an inflamed granulation tissue containing collections of lipophages and densely infiltrated by polynuclear leukocytes, plasma cells, macrophages, and eosinophiles. There are scattered areas of necrosis present. The tissue shows conspicuous proliferation of reticulocytes and histiocytes, some of which present evidence of active phagocytosis."

*Diagnosis:* "Fragments of granulation tissue, rich in lipophages, showing chronic and acute inflammation. The histological picture suggests a chronic low-grade infection with a recent exacerbation."

Cultures of the tissue were negative. After all these examinations and studies, a *definite diagnosis could not be made.*

The patient's condition became more grave. He was unable to eat most foods and lost weight. He complained of considerable pain in the lower back and showed a progressively increasing anaemia with elevation of the white blood count.

The laboratory findings on three different occasions were as follows:

*November 18, 1936*

Hemoglobin—58 per cent.

*December 1, 1936*

Red blood cells—2,480,000
Hemoglobin—42 per cent.
White blood cells—16,300
Neutrophiles—90 per cent.
Eosinophiles— 1 per cent.
Lymphocytes—9 per cent.

*December 7, 1936*

Red blood cells—2,848,000
Hemoglobin—45 per cent.
White blood cells—25,200
Neutrophiles—94 per cent.
Lymphocytes— 6 per cent.

Several autogenous blood transfusions were given, with no improvement of the blood picture.

Large axillary glands on the right were noted for the first time on December 15, 1936, as well as the marked increase in size of the glands in the left inguinal region and, also, on the right inguinal area.

On December 15, 1936, under local anaesthesia, a two-inch transverse incision was made over the enlarged lymph nodes. These presented as a mass of seven or eight greatly enlarged nodes, several of them showing caseous degeneration. They were easily removed and the incision was closed with a fine cat-gut subcutaneous stitch and dermol for the skin.

Pathological examination at this time was as follows:

*Gross:* "Specimen consists of a matted mass of lymph nodes which vary in diameter from one to four centimeters. There are rather dense fibrous adhesions binding the lymph nodes together. The latter are firm in consistency and, on section, show a rather cellular homogeneous grayish-yellow appearance. Some of the nodes show focal yellowish-brown areas of fibrosis and apparent hyalinization."

*Microscopic:* "Sections show a marked proliferation of large atypical cells with pale cytoplasm, apparently of reticular origin. There are many multinuclear cells and numerous mitotic figures. The stroma is infiltrated by many inflammatory cells, principally polynuclear leukocytes with plasma cells and eosinophiles as well. Some of the lymph nodes show a definite tendency to fibrosis and hyalinization. The histological picture suggests Hodgkin's disease in a very active stage with an atypical anaplastic proliferation of reticulocytes."

*Diagnosis:* "Hodgkin's disease."

The patient died on December 22, 1936.

Post-mortem examination showed an extensive spread of the disease with considerable involvement of the abdominal and pelvic glands, which had produced partial obstructions about the head of the pancreas and distension of the gall bladder. There was partial obstruction of the ureters at their entrance into the bladder. The spleen was not enlarged, but showed a few small involved areas. The ribs, the sternum, and the thoracic, lumbar, and sacral spine revealed involved areas not visible roentgenographically. The left psoas muscle was almost entirely replaced by this pathological process. The mediastinal glands were only slightly involved.

## SUMMARY AND CONCLUSIONS

This case presentation is of import chiefly because it shows that Hodgkin's disease with involvement of the osseous system is not a rare condition, and that its possibility must be borne in mind. It shows also that, because of the bizarre manifestations of the disease and the occasional absence of superficial gland involvement, diagnosis may be quite difficult.

Hodgkin's granuloma is primarily a disease of the reticulo-endothelial system, perhaps of an infectious origin, at times with secondary osseous invasions, resulting in either osteolytic or osteoblastic bone manifestations.

Sincere thanks are extended to Dr. Henry Jaffe, Director of the Laboratory of the Hospital for Joint Diseases, for his kind assistance and interest in the handling of this case.

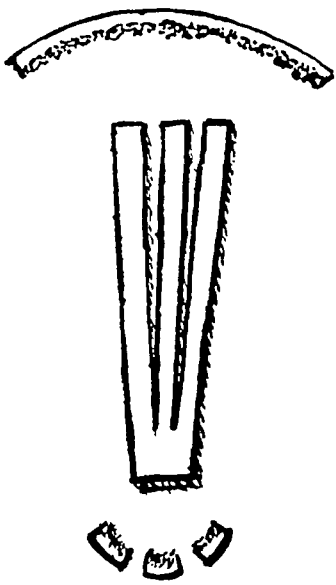


FIG. 1

Graft in different positions.

After deep incision of the aponeurosis, the erector spinae muscles are detached, the laminae are exposed, and the bone is scraped clean of any adherent muscle tissue. The compact layer of bone is also shaved off at this time. The graft is then laid in the junction of the bases of the vertebral spines and the laminae, the cancellous portion of the graft being apposed to the freshened bone.

The author feels that this operation is more efficient than the other two for the following reasons:

1. It is very simple and, with the aid of an electric saw and good assistance, requires from twenty to thirty minutes.

2. The graft is placed deeply, is well covered by the erector spinae muscles, and has a large area of contact with the vertebrae, thus affording a better opportunity for vascularization.

3. If sepsis should develop, causing the graft to sequestrate, a second operation can be done on the other side of the spine.

4. The gibbosity is less pronounced on the laminae than at the spines where a greater degree of bending of the graft is needed.

5. The fusion is near the center of motion of the vertebrae and there is less danger of fracture.

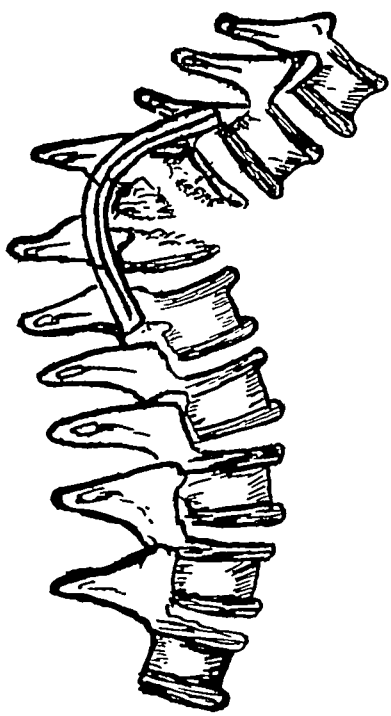


FIG. 2

Spine with graft in position adapted to the curve.

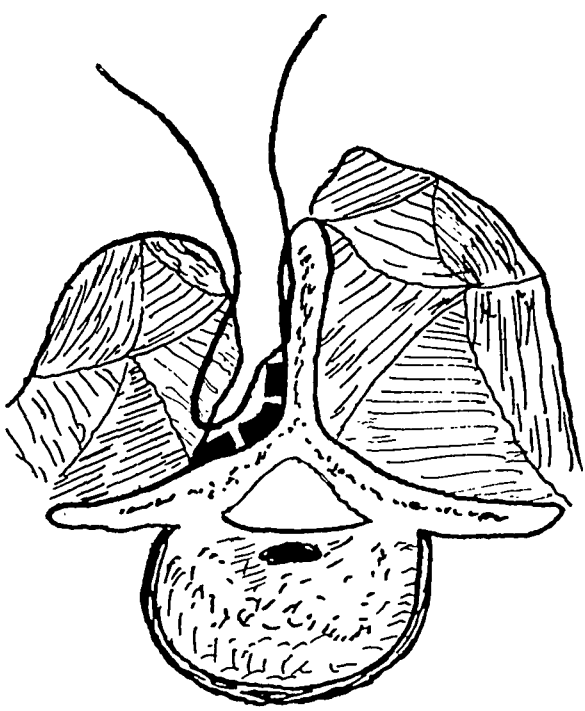


FIG. 3

Graft in position after suturing.

# THE OPERA-GLASS HAND IN CHRONIC ARTHRITIS

## "*La Main en Lorgnette*" of Marie and Léri

BY LOUIS S. NELSON, M.D., BROOKLYN, NEW YORK

*From the Jewish Sanitarium Hospital for Chronic Diseases* *

The object of this paper is to call attention to a rare deformity of the hands occurring in chronic rheumatic disease. The deformity is characterized by telescoping of the fingers produced by absorption of the phalanges; with the absorption of the skeletal supporting structure and the maintenance of the soft parts, transverse folds occur in the excess skin, giving a pawlike appearance to the hand.

Because of this telescoping, Marie and Léri named this condition "*la main en lorgnette*", or the opera-glass hand. In 1913, they described the autopsy findings in the case of a female, seventy years old, suffering from chronic rheumatic disease and presenting this curious deformity. Nothing further in regard to this condition appeared in the literature until 1929, when Weigeldt reported a similar case of chronic polyarthritis with progressive shortening of the fingers, while the skin remained unaffected, producing the transverse folds typical of "*la main en lorgnette*".

When one considers the tremendous number of arthritics found in all countries, it is indeed surprising that the world literature on this subject should be so scant. The following report of a case of chronic rheumatic disease presenting the opera-glass hand is unusual in that this condition occurred in a woman of thirty-one, whereas in the case reported by Marie and Léri the patient's age was seventy, and in the case described by Weigeldt the age of the patient was sixty-four years. In other respects, the similarity of the present case to those reported by the previous authors is striking.

The patient, a white female, thirty-one years old, was admitted to the Hospital for Chronic Diseases in April 1929. At that time, the chief complaints were stiffness in most of the joints, weakness, and deformity of the hands.

The family history, past history, and all the systems were entirely negative.

The patient had been a perfectly healthy and normal child until the age of twelve, when pain had developed in the fingers. The pain was of a sticking character, and the fingers felt stiff every morning, but this passed away as the fingers were manipulated. Several weeks later, the knees became swollen, painful, and stiff. Later the ankles were similarly affected. The patient received a variety of treatments, but grew progressively worse. About one year later, she was admitted to the Roosevelt Hospital where a diagnosis of Still's disease was made. Progressive joint involvement and stiffness continued until she was completely bedridden. The hip joints became involved about nine months after the original onset. The arthritic condition was slowly progressive with accompanying atrophy of all of the muscles and marked weakness and stiffness.

While at the Sanitarium, she had been subject to frequent infections of the upper

* Orthopaedic Service of B. Koven, M.D.

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trachoma with corneal complications was made. The disease was extremely active in spite of intensive treatment.

Physical examination showed a white female, markedly undernourished and underdeveloped, with atrophy of the extremities. She was completely bedridden and practically unable to move except for slight ranges of motion at the shoulders and the elbows. Mentally, she was well oriented and cooperative.

The positive findings were a seborrhoeic dermatitis in the head and chronic conjunctivitis with corneal opacities of the eyes. Scoliosis and stiffness in the spine were noted, as well as complete ankylosis of both hips and knees.

The hands revealed the characteristic deformity of "*la main en lorgnette*". All the fingers were foreshortened. On the right, the thumb and forefinger were markedly telescoped in typical fashion with transverse folding of the excess skin easily seen in Figure 1. An abnormal degree of mobility was present. The other fingers showed telescoping to a less extent. The little and ring fingers exhibited ankylosis at the interphalangeal joints, but were relatively shortened, due to the absorption of the metacarpals. The skin of the finger tips was reddened, hyperaemic, and glossy.

Roentgenograms of the hands (Fig. 2) were strikingly similar to those of the two previously published cases. The right hand presented absorption of the proximal phalanx of the thumb and the adjacent half of the metacarpal. The base of the distal phalanx was absorbed. The second finger showed absorption of half of the shaft of the middle phalanx. The remaining base was ankylosed to the proximal phalanx. The second metacarpal was thinned out and rounded as though dissolved. The knuckle joint had completely disappeared and the finger was telescoped. The third finger showed a similar condition. The proximal phalanx of the fourth finger was in the process of solution. The knuckle joint was telescoped with rarefaction of the bone at the base. The little finger showed ankylosis of the interphalangeal joint, with absorption of more than one-half of the shaft of the metacarpal and the base in the process of solution.

The ulna had been dissolved so that it tapered to a long, thin cone. The carpal bones and adjacent radius were irregularly fused, much of the bone having been dissolved.

In the left hand, a similar solution of the shaft of the phalanges was present, especially marked at the knuckle joints. Here, too, the end of the ulna was cone-shaped. The carpal bones were mostly dissolved, and the whole area was fused irregularly.



FIG. 3



FIG. 1

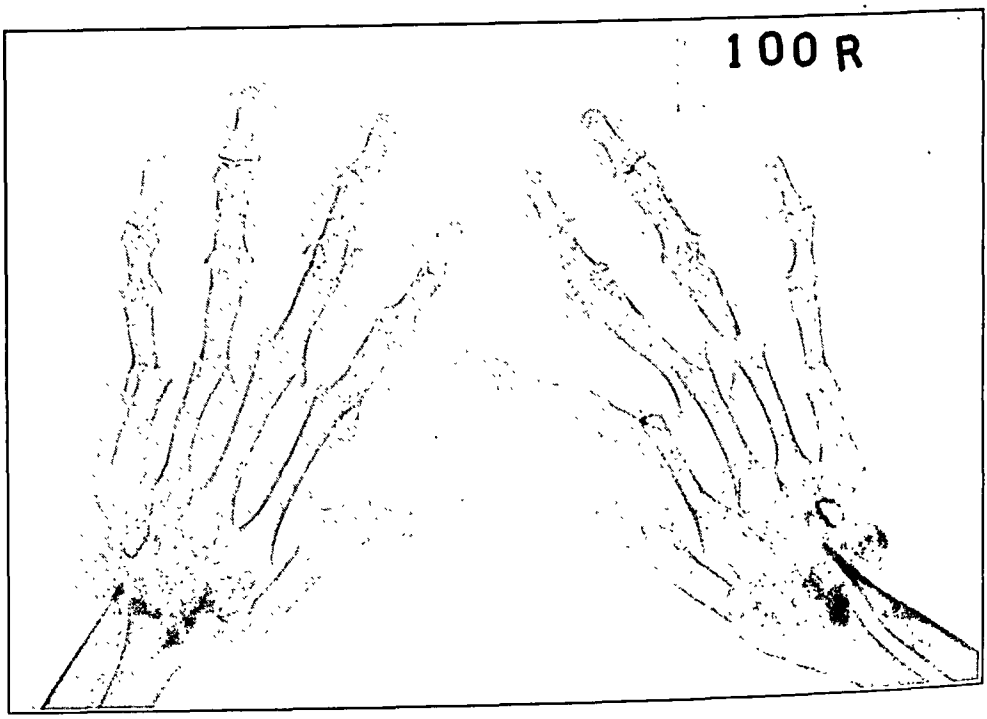



FIG. 2

respiratory tract, but she had had no serious illnesses until January 1932, when a mass had developed in the right hypochondrium, which was diagnosed as a perinephritic abscess. Roentgenographic examination revealed a large calculus in the right kidney. A partial nephrectomy was done. The specimen showed chronic purulent pyonephritis with fibrosis of the parenchyma, and a large renal calculus. The wound drained for several weeks, but was completely healed ten weeks after the operation. In June 1932, a profuse mucopurulent discharge from both eyes developed. A definite diagnosis of

we can only speculate as to the production of bone absorption resulting in "*la main en lorgnette*". We have no positive proof of their connection. During the life of this patient, no diagnosis of hyperparathyroidism had ever been made, nor had the presence of adenoma ever been suspected.

Gutman, Swenson, and Parsons reported a case in which the terminal phalanges were absorbed during the state of hyperparathyroidism. After the removal of the parathyroid adenoma, there was reduction of the phosphatase and serum calcium, resulting in recalcification of the phalanges.

The author wishes to thank Dr. Bodansky and Dr. Jaffe of the Hospital for Joint Diseases for valuable laboratory assistance and Dr. Kantrowitz of the Beth Moses Hospital for his excellent work at the autopsy table.

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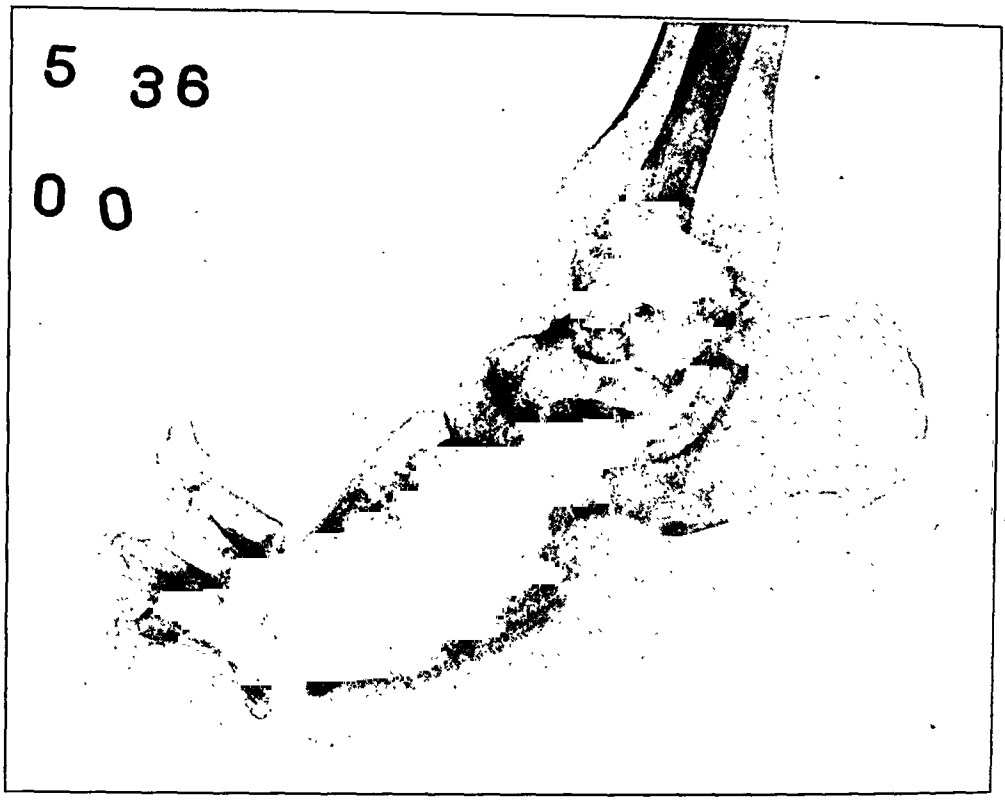



FIG. 4

Both of the ankles were fused in an equinus position (Fig. 3). The feet presented irregular absorption of the metatarsals. Figure 4 shows absorption of the head and adjacent shaft of the first metatarsal of the right foot, with a rounded cone-shaped residual portion. The second metatarsal was tapered to a long thin cone. The heads of the third and fourth metatarsals were in the process of absorption and the head of the fifth showed complete absorption with tapering of the residual shaft. The phalanges also exhibited irregular absorption. The tarsal bones were irregularly fused, and some of them were partly absorbed.

The blood count revealed the presence of a considerable secondary anaemia. The serum calcium was 10.7; the serum phosphorus, 2.9 and the phosphatase, 3.6 units. These are normal findings. The Wassermann reaction was negative, and the test for rheumatoid arthritis was positive in agglutination of specific hemalytic streptococci in dilution of 1 to 1200.

While the patient was under observation, bronchopneumonia developed and she died.

At autopsy, performed by Dr. Kantrowitz at the Beth Moses Hospital, a parathyroid adenoma was discovered. The bones of the hands and several of the long bones were examined; these showed no abnormal changes. There were no abnormal changes in any of the other glands of the body.

The relationship of the parathyroid adenoma and possible hyperparathyroidism to the absorption of bone in the hands provides food for speculation. If we are to consider that during life the blood calcium, phosphorus, and phosphatase were all normal, this would rule against hyperactivity of the parathyroids. The presence of a renal calculus, of bone absorption, and of osteoporosis of bone would possibly indicate parathyroid activity during life. The mere presence of the parathyroid adenoma is presumptive evidence in favor of hyperparathyroidism, but

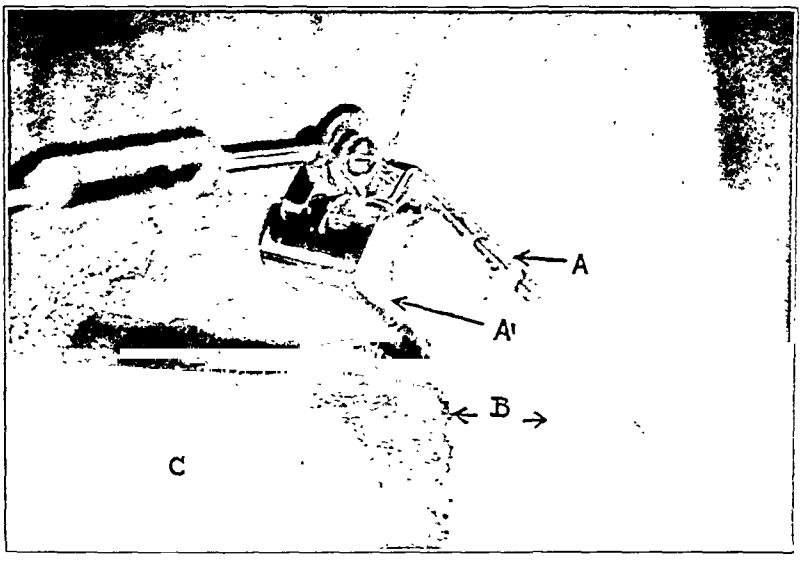



FIG. 3
Showing the application of the lug:
*A:* Upper arm of hinge;
*A':* Lower arm of hinge.
*B:* Edge of cast;
*C:* Patient's body.

any jacket varying between one-half and one and one-half inches in thickness.

The lug shown in Figure 1 is made of aluminum, cast in the form of a hinge, and the two bolts and one nut are of stainless steel. Therefore, the entire assembly is rustproof and in spite of its lightness can withstand a shearing stress of 100 pounds as determined by the manufacturer. *A* and *A'* are the arms of the hinge. *B* is a bolt which fits through a slot in the upper arm of the hinge and can thus be fed into the sleeve, *C*, which, in turn, is part of the lower arm of the hinge. At the distal end of each arm there are two projections which, when the hinge is screwed down, sink into the jacket and thus prevent any lateral motion. Figure 2 illustrates the two lugs and the three sizes of turnbuckles most often used. The slots into which the turnbuckles fit are wide enough to accommodate one of larger size if the necessity should arise.

## METHOD OF APPLICATION

After the wedge has been cut out of the jacket on the convex side of the primary curve and the opposite half of the jacket has been cut transversely to the apices of the wedge previously cut, the jacket is pried apart approximately four inches, in the direction necessary to correct the primary curve, to allow for the insertion of the lugs and the turnbuckle. Next, a hole, one-half an inch in diameter, is drilled through the cast one and one-quarter inches from each cut edge of the jacket with a half-inch bit and any type of auger which will hold the bit. The lug is then applied a-

# A TURNBUCKLE LUG FOR WEDGING JACKETS FOR SCOLIOSIS

BY NICHOLAS J. GIANNESTRAS, M.D., CINCINNATI, OHIO

*From the New York Orthopaedic Dispensary and Hospital*

Wedging-jacket correction of lateral curvature of the spine has been employed at the New York Orthopaedic Dispensary and Hospital, as described by Hibbs, Risser, and Ferguson.[1] Formerly, the turnbuckle lugs were incorporated into the plaster at the time of the application of the jacket. At a later date, incorporation of the lugs into the jacket was discontinued, as it was found that the lugs could be placed more accurately at the time that the wedge was cut out of the jacket, and the cast itself was neater in appearance. Various types of lugs have been tried out from time to time. The one herein described and illustrated has overcome the difficulties experienced with the lugs previously used. The type used prior to the present one had five component parts, and the application required anywhere from fifteen to thirty minutes. Furthermore, due to the varying thickness of the jacket, the bolts used either projected inwardly, causing discomfort to the patient, or outwardly above the external surface of the wedging jacket, catching into the bed linen and thus tearing it. Of course, the thickness of the plaster will vary with the size of the patient and the technique of its application. At this Hospital the average jacket is from three-quarters of an inch to one inch thick. The new hinge lug is so constructed, however, that it will accommodate itself to

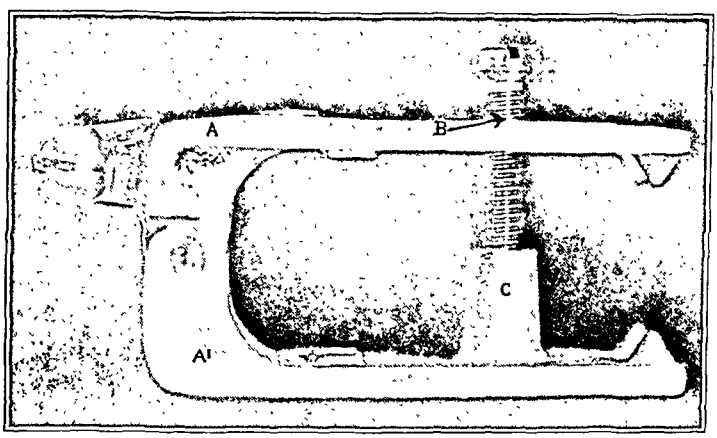



FIG. 1

Showing the construction of the lug.

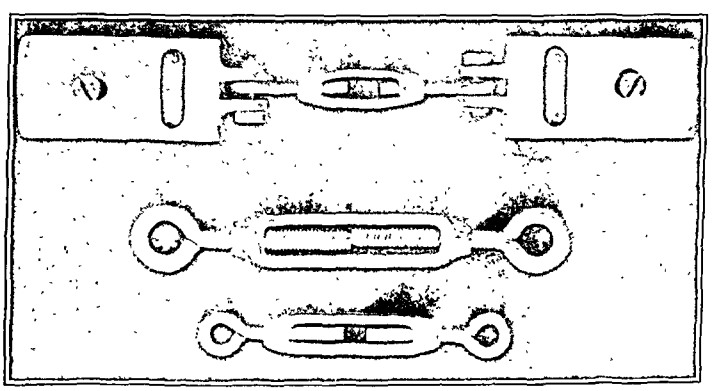


FIG. 2

Illustrating the two lugs and the three sizes of turnbuckles which are most often used.

## METHOD OF BENDING THE TIBIAL GRAFT

The author has found in many cases that a flexible graft is advisable or even necessary. There are several methods of bending the tibial graft to make it fit the kyphotic or scoliotic spine, but nearly all are unsatisfactory. The writer has found that the best way of making a graft pliable is to slice it into several portions and to leave it attached at its base.

The outline of the graft is marked with a knife and, with an electric saw, the longitudinal cuts are made. The graft is then marked into from three to five sections, depending on the size of the graft. These sections are carefully cut to within two inches of the base. Transverse cuts are then made, and the graft is gently disengaged with a knife and removed. It will be seen that the graft is in the shape of a comb, and the divided portions are easily bent. The graft is placed under the erector spinae muscles, and the deep layer of the interspinous ligaments is sutured to the deep layer of the muscles, the stitches being taken quite close together. As the suturing progresses upward, the graft bends and fits snugly over any marked gibbosity.

The author is indebted to Dr. Sorour of the Government Hospital for the drawings which accompany this paper.

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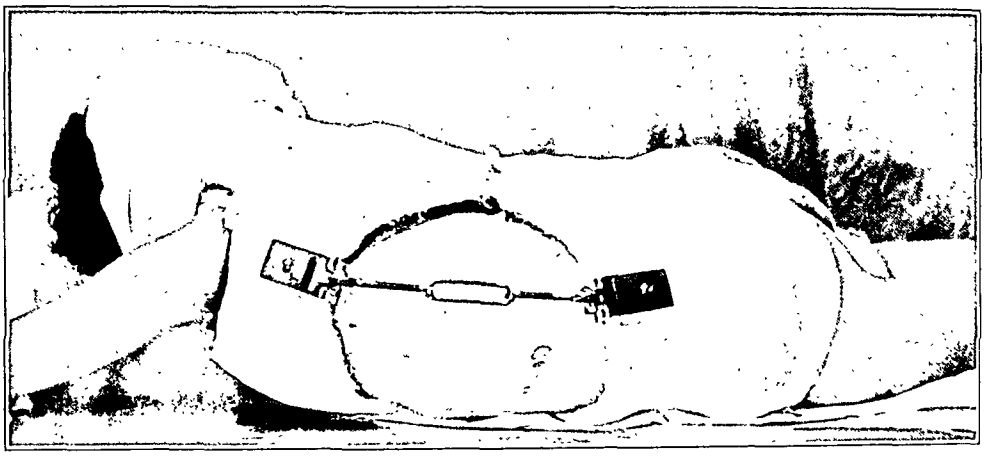


FIG. 4

Illustrating jacket at time of wedging, and the lugs and turnbuckle in use.

follows: The arm of the hinge labelled *A'* in Figure 1 is introduced under the inner edge of the jacket, as illustrated in Figure 3, the sleeve fitting into the hole previously drilled. The arm *A* is then closed down on the outer surface of the jacket, and the bolt *B* is fed into the sleeve and screwed down until the projections bite into the cast firmly and the bolt cannot be screwed down any further. Thus, at the end of this procedure, the hinged lug is tightly in place, and, as seen in Figures 3 and 4, no portion of the mechanism projects either inwardly or outwardly, but the surfaces are perfectly flat.

Because of the simplicity of the application of both lugs and the turnbuckle, the time required for the assembly and application is seldom more than five minutes. The apparatus has been used exclusively since its introduction six months ago at the New York Orthopaedic Dispensary and Hospital and has been found practical and very satisfactory.

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# TWO RARE DISLOCATIONS OF THE METATARSALS AT LISFRANC'S JOINT

BY EDWARD RAYMOND EASTON, M.D., F.A.C.S., NEW YORK, N. Y.

Since dislocations of the tarsometatarsal joints are seldom reported in the literature, the following cases may be of some interest. According to the classification of Quénu and Küss, they belong to the spatular and to the divergent type, respectively. An example of the latter was reported by Ashhurst in 1926.

## CASE REPORTS

CASE 1. *Spatular Dislocation without Fracture.*

N. M., female, thirty-eight years of age, fell down two steps, on April 23, 1937, twisting the forepart of the right foot beneath her. The foot was not caught in any vise-like grip, but the last four metatarsals received the whole impact of her weight. On being helped up, the patient was unable to walk.

When seen by the writer, the foot was considerably swollen and oedematous, with several small blebs and abrasions on the dorsal surface. There seemed to be an unusual prominence of the base of the fourth metatarsal dorsally and externally and a shortening of the foot lengthwise. A roentgenographic examination was made by Dr. W. H. Boone, of Roosevelt Hospital, who made a diagnosis of lateral slipping of the second, third, fourth, and fifth metatarsal bones of the right foot at their proximal articulations, without fracture. The cuboid and external cuneiform appeared to be displaced somewhat inwardly.

The foot was elevated and an alum-acetate wet dressing was applied for three days, at the end of which time the patient was taken to the office of Dr. J. J. Nutt, orthopaedic surgeon at the Polyclinic Hospital. The swelling and discoloration had disappeared to a marked extent, but the deformity was still evident. Dr. Nutt placed the foot in a position of equinovarus, without anaesthesia, and applied a stirrup splint of molded plaster. Roentgenographic examination on the following day showed excellent alignment and apposition of the tarsal and metatarsal bones.

After three weeks, the plaster splint was removed, and the foot was strapped in a position of adduction and inversion. This was repeated weekly for about five weeks, and at the end of that time the foot was normal in appearance, required no further support, and had regained its full functions. The patient, a professional entertainer, was able to perform an intricate dance which she could not have done without perfect use of her foot.

CASE 2. *Divergent Luxation.*

J. L., a schoolboy, aged nine, was knocked down by an automobile on May 30, 1937, his left foot being caught under the wheel. At Knickerbocker Hospital the foot was elevated and dry heat was applied. Roentgenographic examination showed a longitudinal fracture of the navicular, irregular fractures of the internal, middle, and outer cuneiforms, a longitudinal fracture of the cuboid, and irregular fractures of the bases of the second, third, and fourth metatarsals. All these fractures were entirely without displacement of fragments. Apparently the wheel had passed over Lisfranc's joint in a transverse direction. The roentgenogram also revealed a dislocation of all of the metatarsals: the first was displaced inwardly at its base; the four outer ones, externally and dorsally.

When first seen by the writer, there was marked swelling in the region of the tarsometatarsal joint, with blebs and ecchymosis. There was a prominence on the medial aspect of the foot, due to the inward displacement of the first metatarsal, and a corresponding prominence outward and upward over the displaced bases of the second, third, and fourth metatarsals. The entire foot appeared to be shortened.

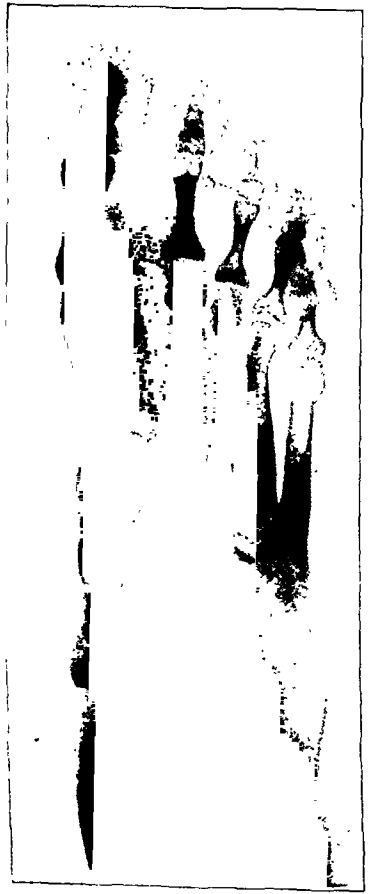


FIG. 1-A

Case 1. Anteroposterior view, showing lateral slipping of the second, third, fourth and fifth metatarsals of the right foot.



FIG. 1–B

Lateral view of right foot, showing displacement of the cuboid and of the external cuneiform, as well as of four metatarsals.



FIG. 1–C

Right foot encased in a plaster stirrup in the equinovarus position. The relation of the bones is restored to normal.

FIG. 2-B

Anteroposterior view of the left foot after reduction.



FIG. 2-A

Case 2. Anteroposterior view of both feet, showing multiple fractures of the tarsal and metatarsal bones and divergent dislocation of Lisfranc's joint of the left foot.

Wet dressings of alum-acetate were applied and elevation of the foot was continued, but on June 11 the roentgenograms still showed an abnormal space between the first and second metatarsals. Closed reduction was attempted, but this failed to improve the luxations. Therefore, on June 22, an open operation, similar to that described by Ashhurst, was carried out under tourniquet as follows:

Under ether anaesthesia, a bayonet-shaped incision was made from the insertion of the peroneus brevis tendon on the lateral border of the foot, extending medially across the dorsum, and downward along the interspace between the fourth and fifth metatarsals. The bases of the four outer metatarsals were found to be luxated dorsally and laterally on the cuneiform bones, confirming the roentgenographic findings. After the soft parts had been elevated from the dorsum of the foot, reduction was secured by leverage over a curved periosteal elevator. Reduction was maintained, making it unnecessary to transplant the peroneus brevis tendon as was done in Ashhurst's case. A second incision was then made longitudinally along the medial side of the tibialis anterior tendon and continued downward over the medial surface of the first metatarsal. The base of the first metatarsal was found riding on the dorsal and medial surfaces of the internal cuneiform bone. Reduction was easily secured, with no recurrence, making it unnecessary to suture the base of the first metatarsal to the internal cuneiform.

The foot was placed in the equinovarus position and dressed with plaster-of-Paris. A roentgenogram, taken after this procedure, showed that the four outer metatarsals were in their normal position. However, there was still present some increased space between the first and second metatarsals. The sutures were removed on the twelfth day, and the wounds remained clean. On the eighteenth day, the plaster splints were removed, and baking and massage were started. It was noted that the patient had not yet attained full control in dorsiflexion of his four outer toes, and that the foot was inclined to slip back into the equinovarus position. After fluoroscopic study of the foot, a posterior molded splint was applied to correct the equinovarus, and physiotherapy was continued.

The splint was removed three weeks later, and the patient began to use the foot. On September 6, examination showed free movement at the ankle and subastragalar joint and full movement of the toes in all directions, but the mid-portion of the foot was entirely immobile, apparently due to an overgrowth of callus at the sites of the numerous fractures. There was no pain on palpation or attempted movement of Lisfranc's joint, and no apparent deformity of the foot was noted except for a slight protuberance on the dorsal surface over the bases of the third and fourth metatarsals, due to the bony overgrowth. The arches were completely preserved, and the patient walked without a limp.

The end results appeared so favorable that the patient was discharged, with instructions to the mother to continue contrast baths and to allow free use of the foot in running and in playing.

Reduction in these cases is usually secured without difficulty. Speed recommends immediate traction on the toes; this may have to be done under anaesthesia if the foot is tender and swollen. Should this not prove successful, open operation must be performed. Judging from the results in the two cases reported here, the prognosis for such injuries is very good.

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# A WIRE TIGHTENER

BY PETER G. SHIFRIN, M.D., ANN ARBOR, MICHIGAN

*From the Department of Surgery, University of Michigan*

Wire as a means of holding bone-fragment surfaces together in close approximation has been used for many years. However, the mechanical efficiency of this type of fixation has often been far from ideal, for it is technically difficult to oppose and to fix bone fragments with wire by using pliers or the wire tighteners now available on the market.

In order to overcome these difficulties, the instrument here presented was designed. The principle of the Parham-band tightener was utilized to this end.

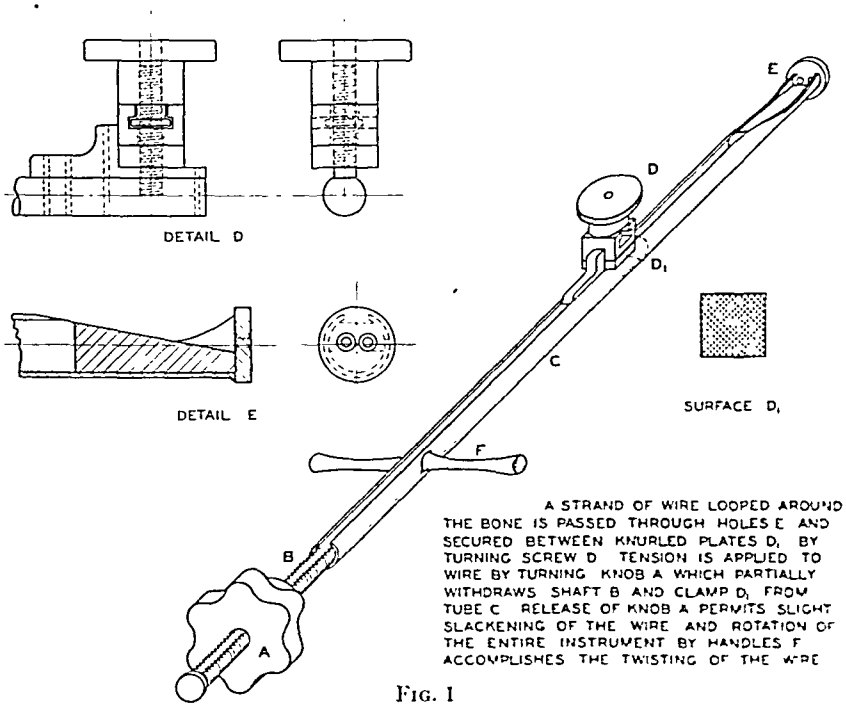



FIG. 1

The instrument is relatively simple in construction and in operation. The wire is passed around or through the bone fragments as the case may be, and the free ends are approximately equalized in length. The ends are now passed through the holes shown in *Detail E* of Figure 1 and are easily secured and pulled through, as the inclined surface immediately above the plate automatically points the wire ends upward. Knob *D* is then unscrewed, thus elevating the upper knurled plate. The wire ends

are placed between the two plates ($D_1$) and knob $D$ is tightened. This firmly secures the wire in the instrument. Knob $A$ is then turned sufficiently to obtain optimum apposition. Here care must be exercised not to apply undue tension, as breaking of the wire may ensue even though the stress is only linear in type. A little preliminary practice will give the operator the necessary experience to enable him to judge the strain to which a given wire may be subjected. Knob $A$ is released about 90 degrees, or slightly more,—that is, no more than to allow just sufficient slack to permit the wires to cross each other when the whole instrument is turned by handle $F$. Further gradual relaxation of knob $A$ will permit gradual completion of as many twists as desired. After the first two complete twists, it is best to apply a hemostat or narrow pointed pliers to the already twisted portion of the wire before further turning is carried out. The heavier the wire used, the more primary relaxation of knob $A$ is necessary before accomplishing the first securing twist.

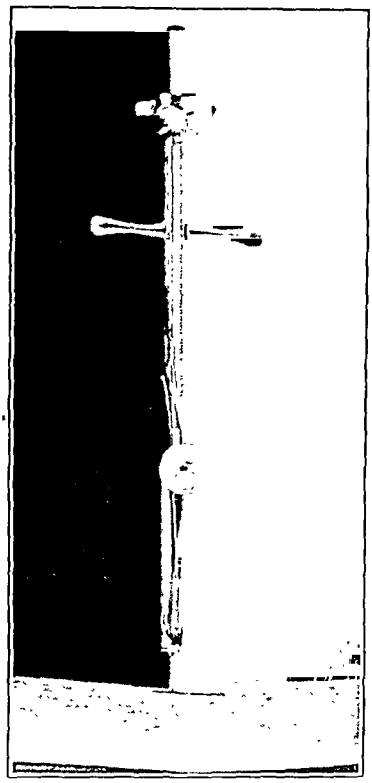


FIG. 2

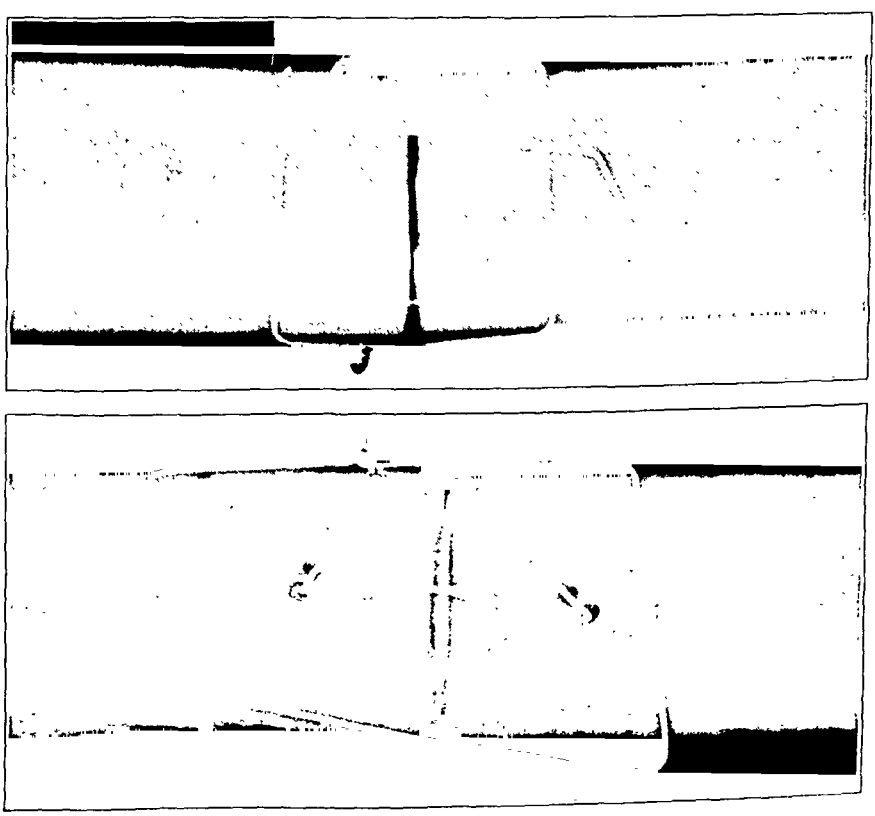


FIG. 3

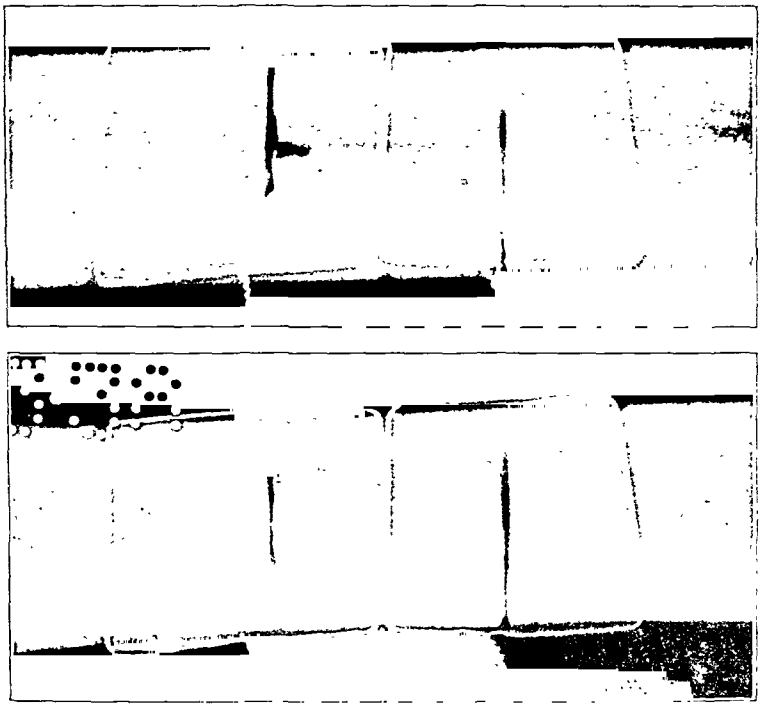


FIG. 4

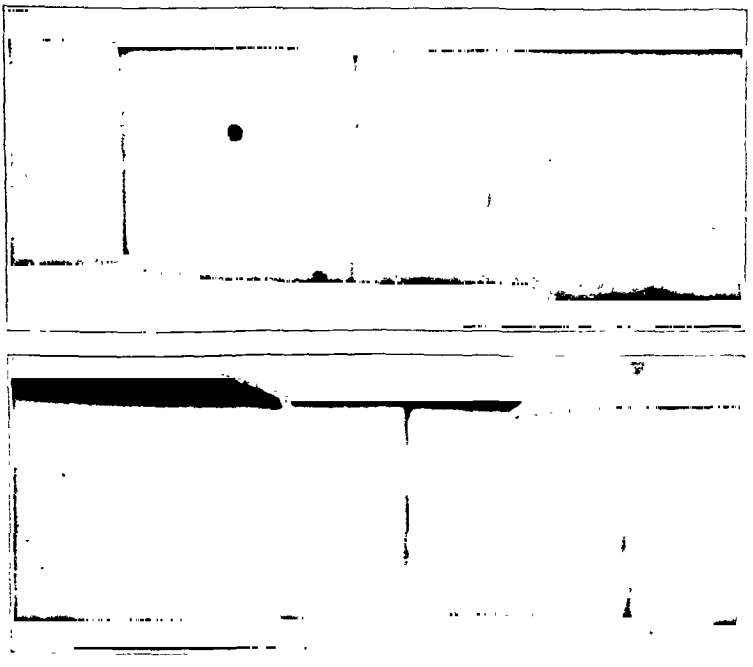


FIG. 5

Figure 2 shows the instrument still attached at the end of this operation. The absolute proximity of the first turn to the bone surface and the close approximation of the fragments are noteworthy.

The variety of loops that one may employ will depend, of course, on the type of bone fragments with which the operator has to contend. Figures 3, 4, and 5 show a few x-rays with a variety of loops to suit the fragments.

This efficient, relatively simple instrument for wire tightening is presented with the hope of aiding the surgeon in proper bone-fragment fixation when that is sought.

# ACUTE MICROCOCCUS CATARRHALIS ARTHRITIS

BY WALTER M. SOLOMON, M.D., AND HENRY R. TUCHEWICZ, B.S., CLEVELAND, OHIO

*From the Departments of Medicine and Pathology of Western Reserve University at Cleveland City Hospital, Cleveland, Ohio*

Micrococcus catarrhalis (Neisseria catarrhalis) is rarely considered a serious pathogenic organism, although it is frequently found in the upper respiratory tracts of normal individuals. During the past twenty years, a few publications in the foreign literature have reported this organism as the etiological agent in such diseases as meningitis, conjunctivitis, panophthalmitis, sinusitis, pneumonia, influenza, septicaemia, and endocarditis. Curtis reported one case in which micrococcus catarrhalis was found to be the cause of a bacteraemia with a subsequent polyarthritic involvement.

The morphological characteristics of the micrococcus catarrhalis and of the gonococcus are identical. The finding of a gram-negative intracellular diplococcus on a smear from the genital tract is usually considered sufficient evidence of a gonococcal infection, and, if a joint is also involved, presenting the typical signs and symptoms, the diagnosis is usually gonorrhoeal arthritis.

This similarity in the clinical picture and the difficulty of distinguishing the two organisms morphologically may lead to an error in diagnosis. To differentiate these organisms, cultural methods are necessary, particularly the fermentation of various sugars.

This possibility of an error in diagnosis and the apparent rarity of micrococcus catarrhalis arthritis warrant the report of the following case.

## CASE REPORT

A. S., a white married woman, sixty-four years old, entered Cleveland City Hospital with symptoms of an acute arthritis of three weeks' duration. The left knee had become extremely painful and swollen and she had been forced to stop work. Subsequently the entire left leg had become swollen. No other joints were involved. One week previous to the onset of the arthritis she had noted a foul vaginal discharge, polyuria, and burning on urination.

The past history was not significant. The patient had eleven children, all living and well.

Physical examination on admission revealed an obese, obviously ill patient with a temperature of 40 degrees Centigrade and a pulse rate of 120. The fundi of both eyes showed marked nicking of the veins. The apex of the heart was in the fifth interspace, twelve centimeters from the mid-sternal line, and an aortic systolic murmur was heard. The peripheral vessels showed moderate sclerosis. Blood pressure was 230/121. The pelvic examination revealed a profuse, foul, yellow discharge. The red and lacerated cervix was not freely movable. The posterior lip bled easily when touched with an instrument. The position and size of the fundus were not determined, due to the patient's obesity. The left leg was swollen, with non-pitting oedema extending from the ankle to

well above the knee. The left knee itself was markedly swollen, tender, hot, and red. Motion was impossible, due to extreme pain.

Laboratory findings showed:

Red blood cells—4,100,000

Hemoglobin (Sahli)—93 per cent.

White blood cells—13,800

Differential (Schilling)

| | |
|---|---|
| Segmented polymorphonuclear neutrophiles | 68 per cent. |
| Stabs | 16 per cent. |
| Juveniles | 1 per cent. |
| Eosinophiles | 2 per cent. |
| Lymphocytes | 12 per cent. |
| Monocytes | 1 per cent. |

Sedimentation rate (modified Westegren)—115 millimeters in one hour; cell volume—34.5 per cent.

Wassermann test—negative.

Smear from the cervix—gram-negative intracellular diplococci.

Urinalysis—specific gravity, 1.044; a trace of albumin; sugar, four plus; acetone, positive, an occasional hyaline cast, and many white cells.

The provisional diagnoses were: acute gonorrhoeal cervicitis; acute infectious arthritis of gonorrhoeal origin, diabetes mellitus; arterial and arteriolar sclerosis with hypertension; and possible malignancy of the cervix.

Two days after admission, the left knee joint was aspirated and two cubic centimeters of purulent material was obtained. The purulent material was streaked out on several plates of Levinthal medium, to which ascitic fluid in the proportions of 4 to 1 had been added, and also on two plain agar plates. The Levinthal ascitic plates were placed in moist chambers and incubated at 37 degrees Centigrade. The agar plates were placed in an incubator at a temperature of 37 degrees Centigrade. After incubation of twenty-four hours, the Levinthal and agar plates showed abundant growth of colonies varying in size, grayish white, translucent and smooth, with a glistening surface, a slightly elevated center, and an irregular edge. The Levinthal plates were covered with a 1-per-cent. solution of tetra-methyl-p-phenylenediamine-hydrochloride.[2] The colonies did not develop the bright purple color characteristic of gonococci. Gram stains of colonies from both Levinthal and agar plates showed gram-negative diplococci in pairs and in clumps. Transplants from the original plates to sugar-fermentation tubes showed that after seventy-two hours the organisms did not ferment dextrose, lactose, maltose, or mannite. The laboratory diagnosis was micrococcus catarrhalis.

The joint was again aspirated eleven days later, when twenty cubic centimeters of purulent fluid was obtained, from which micrococcus catarrhalis was again obtained by culture. One month after admission the joint was aspirated, but the culture at this time was sterile.

A smear from the cervix was cultured and the report from the laboratory was: "Direct smear—Mixed flora with many gram-negative diplococci, of which only a few are intracellular." Micrococcus catarrhalis was isolated by the cultural method outlined above. This also changed the diagnosis to acute micrococcus catarrhalis cervicitis.

A roentgenogram taken four days after admission, or twenty-five days after onset of the symptoms, showed "narrowing of the medial portion of the joint with slight irregularity of the joint margins." A biopsy of the cervix was done one month after admission and the diagnosis was chronic endocervicitis. Diabetes mellitus was confirmed by the finding of a blood sugar of 220 milligrams per 100 cubic centimeters.

Therapy to the joint consisted of immobilization and local radiant heat. The diabetes was controlled with insulin and dietary measures. Forty days after admission the patient was up in a chair. The objective signs of inflammation of the joint had gradually subsided, although motion was limited and caused moderate pain. Subsequent physical

therapeutic measures in the form of local radiant heat, massage, and exercises restored the joint practically to normal function.

The final diagnoses were: arthritis and cervicitis due to micrococcus Catarrhalis; diabetes mellitus; and arterial and arteriolar sclerosis.

## SUMMARY

In this case of arthritis, due to micrococcus catarrhalis, the clinical picture was that of gonorrhoeal arthritis. Organisms aspirated on two occasions from the joint and those found in a cervical smear were identical with the gonococcus morphologically, but cultural methods showed them to be micrococcus catarrhalis. Treatment resulted in complete restoration of function.

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# INTRACAPSULAR FRACTURE OF THE NECK OF THE FEMUR

## Case Report and Pathological Study

BY LAURENCE JONES, M.D., AND B. ALBERT LIEBERMAN, JR., M.D.,
KANSAS CITY, MISSOURI

Fractures of the neck of the femur are unique. There is almost general agreement that in such fractures imperfect reduction results in non-union, while in other fractures imperfect reposition is often followed by union. Efforts at better reduction with the aid of the lateral roentgenogram have been rewarded with improvement in end results. Many observers [1, 2, 3] believe that the failure to recognize this fact is the chief cause of disaster.

Speed recently expressed the opinion that there are additional unknown factors when he entitled an address on fractures of this type, "The Unsolved Fracture".

The case which the authors wish to present indicates that sometimes this condition is a pathological fracture, and that the same fault which causes the fracture is the one responsible for delayed healing or even complete non-union. These cases are probably doomed to non-union at the moment of fracture. With our interest directed to this point, additional material is being studied which would tend to confirm this view.

No attempt will be made to discuss the anatomical conditions which favor non-union, as they have been so adequately presented by Phemister and by Santos. The description will be limited to the pathological changes that have been found in patients dying shortly after femoral-neck fractures, and to the inferences that can be drawn from these studies. Although early death after fracture occurs frequently, there are in the literature very few complete pathological descriptions of the fracture site. Both Phemister and Santos have included such a description, and the pathological study here reported was made earlier after the injury than either of theirs.

Phemister reported the case of a female, aged seventy-five, who had fractured the neck of the right femur fifteen days before death. Pathological specimens showed bone necrosis along the fracture line with erosion of the neck well under way. He concluded that "non-union might have been the result but delayed union after more erosion of the neck might have occurred".

Santos reported the pathological findings following a fracture of the neck of the left femur in a man eighty years of age. Death occurred twenty-four days after injury. This case fell into the group of impacted fractures. In spite of close bony apposition, there was considerable necrosis along the line of fracture without any evidence of either fibrous or osseous repair.

active and an influential member of the local and national medical societies, and his counsel was sought in all of them.

His membership in the American Orthopaedic Association, with which he was associated in the early period of its existence, was distinguished by constant activity and interest. He was President in 1918, and he served as its Treasurer for twenty-six consecutive years, a position which he still held at the time of his death and which he had tried to relinquish, but his fellow members would not concur in this action. He managed the affairs of this Association with great judgment, and his influence in the conduct and establishment of its policies was not exceeded by any one of its members. His opinion was always a guiding force because of the confidence which he inspired in every member.

Dr. Porter enlisted early in the World War, and was Chief in his department in one of the important hospitals, where he organized and conducted an active and most efficient service. Particularly successful was the cooperation which he established with other groups in the same unit. He was able to contribute his skill and the results of his experience as an orthopaedic surgeon, and also as an administrator, to bring to the wounded under his supervision all the advantages of the different agencies which were then active, in order to obtain for these men the means which might restore them as nearly as possible to the normal. To this military service he gave all his time and energy during the war and in the post-war period, until relieved from active duty. He then slipped quietly back into his own individual work, leaving an enviable record.

The consummation of a successful life, which has been the fulfilment of an idea and the attainment of a purpose, is a legacy which serves as a guiding force and an inspiration to those who follow and to those who have need of a steadying influence in working out their own life problems. Perhaps during his early years he became imbued with the quiet strength of the New England hills, which by their steadfastness and sturdiness helped to mold the character, the basic traits of which he inherited from his parents. The courage, the strength of conviction, and the honesty of purpose were certainly there, and showed their influence in all his accomplishments. No greater tribute could be paid to anyone than the recognition of the success of a purposeful life and the gratitude of the host of those who have benefited by his kindly generosity throughout his career. His name will stand at the head of the list of those who have been preeminent in their love for their fellow men.



## JOHN LINCOLN PORTER

JULY 2, 1864–AUGUST 11, 1938

Born in New England, among the hills of New Hampshire, Dr. John Lincoln Porter died in his adopted city of Chicago, in active service, after seventy-four years of a strenuous, successful, and productive life, loved by all his friends, esteemed by all who knew him, and respected by his associates for his sturdy character, so evident in all his dealings.

He began life with a purpose, and his subsequent career was a history of its accomplishment and the trueness of the aim to which he kept. In his determination to devote himself to the profession of medicine he never wavered, and he was never turned aside by obstacles which presented themselves or by difficulties which intruded along the way. Beginning with his efforts to obtain a medical education and continuing during the early period of establishing his professional position in his city, he showed a courage and a determination in regard to the uncertainty of the future which were evident throughout his life. He held the highest positions in the institutions of his community; he was an

The Annual Meeting of the **Société Française d'Orthopédie et de Traumatologie** will be held in Zurich and Lausanne on September 26, 27, and 28, 1938. On the first day, the members will visit the *Institut Balgrist* and the *Clinique "Hirslanden"* in Zurich, where cases will be presented and operations demonstrated by Prof. Scherb, Dr. Francillon, Dr. Burckhardt, Dr. Mülli, Prof. Dubois (Berne), Prof. Clairmont, Prof. Zollinger, Prof. Monnier, and Dr. Debrunner. The second day will be devoted to an automobile trip through Lucerne, Interlaken, and Montreux to Lausanne. On the third day, case presentations and demonstrations of operative technique will be given at the *Hôpital Cantonal de Lausanne* and the *Clinique Médicale du Hôpital Nestlé*, in which the following surgeons will take part: Prof. Nicod, Dr. Scholder, and Prof. Reinbold, of Lausanne; and Dr. Martin-du Pan, Prof. Jentzner, Dr. Fauconnet, Dr. Brocher, Dr. Oltramare, and Dr. Perrot, of Geneva. The final day will be left open, so that the members may have an opportunity to visit the places in which they are most interested.

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The Annual Meeting of the **British Orthopaedic Association** will be held in Birmingham on October 21 and 22, 1938.

At a recent meeting of the Executive Committee, the following orthopaedic surgeons were elected to Associate Membership in the Association:

Mr. L. O. Betts, 196 North Terrace, Adelaide, South Australia.
Mr. James P. Campbell, Harlow Wood Orthopaedic Hospital, near Mansfield, Nottinghamshire.
Mr. F. P. Fitzgerald, Royal National Orthopaedic Hospital, 234 Great Portland Street, London, W. 1.
Mr. D. W. Griffiths, Manchester Royal Infirmary, Manchester, 13.
Mr. H. E. Griffiths, 90 Harley Street, London, W. 1.
Mr. G. T. Partridge, Charing Cross Hospital, London, W. C. 2.
Mr. F. G. S. C. Strange, St. James Hospital, Ouseley Road, Balham, London, S. E.
Mr. R. G. Taylor, Royal Infirmary, Sheffield.

The following surgeon has been made a Full Member of the Association:
Mr. E. B. M. Vance, 159 Macquarie Street, Sydney, New South Wales.

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The Third Congress of the **Sociedade Brasileira de Ortopedia e Traumatologia** took place on July 1, 2, and 3, 1938, in Recife, Brazil, under the presidency of Prof. Barros Lima.

The principal subjects, which were chosen for discussion at the last Congress, were: "Fractures of the Ankle" and "Sequelae of Infantile Paralysis". Two papers on these subjects were presented by Dr. Orlando Pinto de Souza and Dr. Godoy Moreira.

Prof. Mario Ramos presented an excellent study on "The Bacteriological Diagnosis of Osteo-Articular Tuberculosis by the Culture of Koch's Bacillus. Prof. Define spoke on "Pre-Luxation of the Hip" and presented personal cases. Prof. Barros Lima gave an interesting study on "Subtrochanteric Osteotomies" with indications for their employment.

At the business session on July 3, the following officers were elected:
President: Prof. Barros Lima
Vice-President: Dr. Godoy Moreira
General Secretary: Dr. Renato Bomfim
Assistant Secretaries: Dr. Itapema Alves and Dr. Alcino Coimbra
Treasurer: Dr. Domingos Rezende
Librarian: Dr. Ulysses Barbuda.
Prof. Rezende Puech was chosen Honorary President of the Society.

The next Congress will take place in São Paulo, in July 1940, under the presidency of Prof. Define. The following subjects have been chosen for discussion: "Fractures of the Spine" and "Lumbar Pain".

# News Notes

The Seventh Annual Convention of the **American Academy of Orthopaedic Surgeons** will be held in Memphis, Tennessee, from January 15 to 19, 1939, under the Presidency of Dr. John C. Wilson. The full program for this meeting will appear in the January issue of *The Journal.*

The Annual Roll Call of The **American Red Cross** to enlist members for 1939 will be conducted throughout the nation from November 11 to 24, 1938.

Dr. Seth Selig and Dr. Robert K. Lippmann have been made Attending Surgeons on the Orthopaedic Service of Montefiore Hospital, New York City.

The next meeting of the **Orthopaedic Guild** will be held in Toronto, Canada, on November 25 and 26, 1938, under the Chairmanship of Dr. A. W. Farmer, 407 Medical Arts Building, Toronto.

The **Pan-Pacific Surgical Congress** will be held in Honolulu in September 1939. Any person desiring to present an orthopaedic paper before that Association should address the American Chairman for the Orthopaedic Section, Dr. Steele F. Stewart, 3780 Wilshire Boulevard, Los Angeles, California.

The Sixty-Seventh Annual Meeting of the **American Public Health Association** will be held in Kansas City, Missouri, October 25 to 28. More than 400 papers and reports will be presented and discussed and a special session will be devoted to a consideration of "Public Health Aspects of Medical Care". Further information may be obtained from the Association's headquarters, 50 West 50th Street, New York, N. Y.

The Fourth **World Conference of Workers for Cripples** is to be held in London, at Bedford College, from July 15 to 22, 1939, under the auspices of the Central Council for the Care of Cripples. Three subjects have been selected for discussion: (1) Preventive Orthopaedics in Childhood; (2) The Education, Vocational Training, and Subsequent Employment of the Crippled Child; (3) The Industrial Cripple. Discussion on the third topic will be opened by a member of the staff of the International Labour Office, which has an immense amount of material at its disposal relating to every country in the world. An interesting program of discussions and visits to institutions and other places of interest has been planned. Further information may be obtained from the Organising Secretary, 34 Eccleston Square, London, S. W. 1.

The Eighth Congress of the **Association Internationale de Thalassothérapie** was held from June 3 to 6, 1938, at Montpellier and Palavas, France. The Congress was opened by Rector Pariselle, who represented the Minister of National Education.

The subject of the scientific sessions was "Tuberculous Peritonitis", and a large number of interesting papers were presented and discussed by the members and guests. The results of heliotherapy in high altitudes and by the sea were compared and the relative values of operation and treatment by this therapy were discussed. The Congress was able to demonstrate the very great benefit obtained by this form of therapy, especially in preparing patients for operation.

During the four days of the Congress, the members were given the opportunity of visiting the hospitals of Montpellier and the sanatoria of Palavas and Grau-du-Roi, as well as places of historical interest in the vicinity.

Clinically, the most important type is the traumatic necrosis which either is the result of direct injury, such as fractures of the bones, contusions of the superficial membranes of the joints, and osteochondritis dissecans, or is secondary to fractures of the neck of the femur, to trauma to the spine (Kümmell-Verneuil disease), or to certain operations (transplantations, reductions of congenital dislocations, and operations on the head of the femur). He also discussed the relation of aseptic necrosis to spontaneous necrosis of the femoral head in Legg-Calvé-Perthes disease and to necrosis of the scaphoid. He suggested the advisability of designating all these conditions by anatomical names and eliminating all those terms which do not indicate the anatomical changes.

Dr. Jaroš called attention to the importance of fractures and necrosis of the lunate from the point of view of insurance.

Papers were also presented by Dr. Hanák, Dr. Grospić, Dr. Delić, Dr. Jaroš, Dr. Hanausek, Dr. Pavlík, Dr. Jeřábek, and Dr. Pavlnský on the following subjects: surgical treatment of scoliosis, arthrodesis of the hip, different forms of fixation of the hip by graft, the relation of malposition of the lower part of the pelvis to torticollis and congenital luxation, measurement of joint mobility, the results of experiments in the transfusion of white blood corpuscles, the stimulation of bone growth by mechanical irritation, such as the driving in of a nail, etc., the result of removing the upper anterior edge of the acetabulum in the Smith-Petersen operation, and the differential diagnosis of vertebra plana.

Prof. Zahradníček was re-elected President. The next Congress will take place at Prague in the spring of 1939.

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## EDVILLE G. ABBOTT

NOVEMBER 6, 1870–AUGUST 27, 1938

Dr. Edville G. Abbott died suddenly on August 27, 1938, at the age of sixty-eight, at his home in Portland, Maine.

Dr. Abbott came from a race of seafaring people and inherited much of their sturdy character. After his preliminary studies, he entered Bowdoin Medical School, from which he was graduated in 1898. He continued his studies in this country and abroad, and established himself in practice in Portland in 1901. Dr. Abbott was a strong influence in the establishment of orthopaedic surgery in his state and particularly in Portland. He was a pioneer in his specialty in his chosen city, and his life is a record of many accomplishments as the result of his industry, skill, and forceful character. Dr. Abbott held important positions in the principal institutions in Portland, as well as being a consultant in many other hospitals in his city and state; he was the first Surgical Chief in the Children's Hospital, in the establishment of which he was largely influential, and was Chief Orthopaedic Surgeon in the Maine General Hospital. He had received honorary degrees from several colleges.

Dr. Abbott took an interest in the treatment of scoliosis at a period when this important condition was attracting but little attention, mainly because of the discouraging results, and he became internationally prominent through the original and forceful method of treatment which he advocated. He was responsible for the stimulation of an active interest in the treatment of this affection in the orthopaedic world, both in the United States and abroad, and this continued active interest has been productive of a very decided advancement in the understanding and treatment of this affection.

The Thirty-Third Congress of the **Deutsche Orthopädische Gesellschaft** will be held in Giessen on October 3, 4, and 5, 1938, under the Chairmanship of Prof. Peter Pitzen. The subjects for discussion are as follows: Orthopaedic Surgery and Working People; Orthopaedic Technique; Orthopaedic Surgery and Gynecology; Primary Bone Tumors; Vitamins and Hormones. There will also be several papers on various other orthopaedic subjects presented by members and guests.

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At the **Réunion d'Orthopédie et de Chirurgie de l'Appareil Moteur de Bordeaux,** held on June 30, 1938, the following papers were presented:

Myeloma of the Humerus—Dr. R. Dieulafé.

Fracture of the Epitrochlea; Inclusion of a Fragment in the Articulation of the Elbow—Dr. M. Touya.

Nailing of the Neck of the Femur; Description of an Apparatus to Aid in this Procedure—Dr. M. Touya.

A Case of Fracture of the Acetabulum with Intrapelvic Luxation of the Femoral Head—Dr. J. Magendie.

Congenital Articular Rigidity of the Limbs in a Boy of Twelve Years—Prof. P. Nicod.

Two Cases of Epiphysitis of the Second Metatarsal—Dr. R. Guérin and Dr. R. Fourcade.

Radial Club Hand—Dr. H.-L. Rocher.

Apparatus for Congenital Luxation of the Hip—Dr. Charles Lasserre.

Continued Traction by the Kirschner Wire—Dr. Charles Lasserre.

Diagnosis of Chronic Synovitis in the Adolescent and in the Adult—Dr. Charles Lasserre.

Old Malunited Fracture of the Elbow, with Total Disability; Result of Reparatory Treatment—Dr. R. Charry and Dr. G. Charry.

Dystrophy of the Lower End of the Femur in a Child of Three Years—Dr. Edouard Papin.

Indications for Tarsectomy in Osteo-Arthritis of the Anterior Tarsus—Dr. Andrieu.

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The Annual Congress of the **Czechoslovakian Orthopaedic Society** was held in Prague on July 8 and 9, 1938, under the presidency of Prof. Dr. Zahradníček.

The program consisted of two principal papers,—"Pseudarthrosis", by Prof. Zahradníček; and "Aseptic Necrosis of Bone," by Prof. Frejka.

In speaking on the subject of pseudarthrosis, Prof. Zahradníček stressed the consideration of the development of the callus, the importance of the hematoma in the wound, and the metaplasis of the callus, the normal growth of which is influenced by static-dynamic forces. He mentioned the conditions which have an unfavorable influence on osseous union,—poor reposition, insufficient fixation of the fragments, eburnation of the extremities of the bones, interposition of the muscle, and infection. He advocates long-continued fixation in a well-applied plaster bandage, and believes that age does not particularly influence pseudarthrosis. He also stressed the importance of proper nourishment, the influence of vitamins, sympathectomy, and the drilling of the bone. In surgical treatment it is necessary to eliminate as much of the scar tissue as possible, to make complete correction of the deformities, and to open widely the medullary cavity. He advised against the use of any internal fixation such as a medullary graft, and recommended the transplanation of bone in the more extensive defects.

The subject was discussed by Dr. Havránek, Prof. Burian, Dr. Grospić, Dr. Pavlík, Dr. Vavrda, and Dr. Stepán, who added the results of their experience in the treatment of this rather intractable condition.

In his paper on aseptic necrosis of bone, Prof. Frejka stated that this condition is now interesting the medical profession and is receiving a great deal of attention. It is known that necrosis often arises from inflammatory conditions, from tuberculosis, from lues, from chemical irritations, and from treatment by the roentgen ray and radium.

stand up, upon condition that he undergo a regular check-up for a long time (one to two years)."

In 1933 only nine cases were observed sufficiently long to draw any conclusions. In a tenth case that was untreated, spontaneous recovery took place after a period of four years. This somewhat confounded Dr. Harrenstein.

In 1936, thirty-seven cases were reported with the following results:

| *End Result* | *No. of Cases* |
|---|---|
| Cured | 11 |
| Not cured | 11 |
| Still being treated | 10 |
| Dead | 1 |
| Impossible to judge | 4 |

The duration of check-up in the cured cases ranged from one year to six years after the end of treatment.

A study of the check-up examinations of the nine children affected with multiple deviations at the beginning of the treatment showed the following results: cured, one case (check-up after four years); improved, three cases; aggravated, three cases; still being treated, two cases.

"After a follow-up examination, four years later, of patients whom we were able to locate, we ascertained that, of four patients considered as cured in 1928, three remained completely normal. This short summary of the experience of the author with this treatment shows that, even with these young children, only a certain percentage may be considered as cured. Some errors committed in the treatment have provoked the formation of compensating curvatures in the lumbar region, and some permanently exaggerated corrections have also arisen. Furthermore, the results have often been incomplete, due to insufficient cooperation of the parents, who either did not apply the treatment prescribed or did not apply it long enough."

Antirachitic prescriptions are indicated as a rule, although about four-fifths of the cases reported were thought not to be of rachitic origin. According to Dr. Harrenstein, the growth differential is almost always the underlying cause. He makes no mention of posture *in utero* as even a possibility in his causal relations. No compensatory curve should be developed; the corrective treatment should be terminated when roentgenographic studies show that the spine has returned to the position of a straight line. The child must never be allowed to sit or to stand. For twenty hours a day the patient is kept in the plaster bed, and for four hours he is kept on his face in a simple canvas corset, during which time he can exercise more fully. The plaster should not be changed until the child has outgrown or destroyed the bed. The Jansen plaster bed cannot be used for small children.

RÉSUMÉ

"We see more frequently in infants and in children of lower age groups fixed lateral curvature of the vertebral column than congenital scoliosis caused by anomalies of the skeleton. These lateral curvatures do not show on roentgenographic examination any anomaly of development. The symptoms are not observed at birth and do not develop for several months. The formation of the curvature is not appreciably influenced by the fact that the mother carries the infant on her arm.

"It has been shown that rachitism is not a causal factor in most instances. It has been demonstrated that this early scoliosis can be cured in 50 per cent. of the cases by the institution of careful treatment. The fact that slight cases have improved without treatment should not permit us to wait before attempting correction. The risk of aggravation is enhanced by waiting. Fixed curvatures should be considered the beginning of a scoliosis which may not be recognized until considerably later. Orthopaedic supervision should be recommended early in the infant's life, so that recognition of these disturbances can be appreciated."

## SCOLIOSIS IN YOUNG INFANTS

NOTE: In view of the current marked interest in the subject of scoliosis, Dr. Charles W. Goff, of Hartford, Connecticut, has prepared the following abstract of a number of articles written by Dr. R. J. Harrenstein, of Amsterdam, for the *Zeitschrift für orthopädische Chirurgie* and *Revue d'Orthopédie et de Chirurgie de l'Appareil Moteur*. Dr. Goff has also had the opportunity of observing Dr. Harrenstein's work at the *Emma-Kinderkrankenhaus* in Amsterdam.—*Editor.*

In a comprehensive study of scoliosis in very young infants, Dr. Harrenstein points out that the early discovery of this deformity rests with the paediatrician, and emphasizes the importance of more careful observation in order that no case may be overlooked.

Believing that many children show an asymmetry of the thorax very early, he proceeds to demonstrate the rate of growth and shape of the rib cage by means of cross-sections and through the use of roentgenographic studies of rib epiphyses. At birth, and until from five to nine months of age, the thorax is relatively square, with the corners of the square slightly rounded. At one year of age, the anterior portion of the thorax begins to show less rapid growth, with a greater curving of the posterior angles, so that at six years of age the thorax is egg-shaped. Any interference with growth in one or more rib epiphyses will produce inequality, and generally a gibbosity develops. This predisposes to scoliosis, and eventually a total or a mixed type of scoliosis may follow. Actual measurements of ribs from dried specimens are presented, which show an early scoliosis with a gibbosity to prove his theory of growth inequality. Dr. Harrenstein believes that a rachitic background accounts for but a very small number of the cases in his series.

Two cases are reported in which a gibbosity occurred with a kyphosis and not as the result of scoliosis. Both patients had developmental changes in the bodies of at least one vertebra, which allowed the trunk to slump forward. The mechanical failure is identical with Pott's disease.

The corrective form of treatment employed by Dr. Harrenstein in cases of infantile scoliosis consists of the application of a plaster posterior shell or "*Gipsbett*", the anterior portion of which is open; straps alone hold the infant within the bed. To apply this shell, the infant is placed with his face upon a board punched with holes. The correction is obtained by lateral bending and is maintained by inserting rods into holes nearest to the position of correction. "The head, which rests on a cushion, must be held so that the mouth and nose are completely free. Both arms are fastened to the edge of the table with bands. After that a few rods are placed in the board along the patient's pelvis and as high as the axillae, directly against the trunk. The length of the rods is such that they do not extend above the trunk. To give the cast a corrective shape, one may, with the help of hand pressure (toward the right, for example), displace the spinal column, which is convex toward the left, and keep the position thus obtained by placing a few rods along the left side of the trunk. Before making the plaster bed, it is also necessary, depending upon the site of the costal projection or gibbosity, to put a cushion of wadding or felt against the flattened part of the back. In this way a hollow in the plaster is obtained, giving the space necessary for restoring the normal shape.

"One must also place a cushion over the place where the gibbosity is situated. When the curvatures are multiple, the corrective action should be exercised by means of several cushions.

"The costal gibbosity generally disappears rather quickly. If, after a few months of this treatment, it is ascertained by roentgenographic examination that the spinal column is straightened and that the costal projection has disappeared, the time of dorsal recumbency in the plaster is diminished, while the period of ventral recumbency is consequently prolonged. It is not until much later that the patient may sit up or

CASE REPORT

Mrs. E. D., fifty-two years of age, slipped and fell directly on the lateral aspect of the right thigh on April 16, 1933. Three hours later she was hospitalized and anteroposterior and lateral roentgenograms were made. They showed a comminuted fracture of the right femur with two distinct fracture lines; the shaft lay behind the trochanter. One fracture line involved the base of the neck and the other, the trochanter. (See Figure 1.)



FIG. 1

Anteroposterior roentgenogram showing comminuted fracture through base and neck of trochanter with displacement of fragments.

The patient had suffered three previous fractures,—one of the upper end of the right tibia below the knee in 1902; another of the lower end of the left tibia in 1905; and the third of the upper end of the right humerus in 1923. All of these healed normally and without any residual deformity or permanent limitation of joint motion. The patient had also been treated for diabetes mellitus before the present injury.

Examination revealed the usual findings associated with fractures of the neck of the femur. Because of the diabetic history and shock, reduction was delayed for eight days.

An electrocardiogram was taken during this period and found to be normal. When the patient's temperature dropped from 102 degrees to normal, reduction was advised. Due to comminution and the nature of the displacements, internal fixation was selected. On April 24, 1933, eight days after the injury, under general anaesthesia, the following procedure was instituted: Through a typical Smith-Petersen incision the head and neck of the femur were exposed. Intracapsular and intertrochanteric fractures were visualized. An interlocking metal screw was applied, fixing the head and neck to the trochanter. The wound was closed, and a plaster spica was applied with the right leg abducted and internally rotated. About seven hours later the patient complained of dyspnoea and expired within a few minutes.

An immediate necropsy disclosed a large infected thrombus in the iliac vein near the site of fracture, and the cause of death to have been multiple pulmonary emboli.

The gross specimen of the head and proximal portion of the neck of the femur (Fig. 2) showed a central linear defect, due to the insertion of a bone screw. The remaining portion of the neck was occupied by a large triangular defect marked by a complete absence of endosteum. Only a cortical shell remained in the inferior portion of the neck. This cavity was filled with brownish granular detritus,—bone sand. The cartilage covering the head was smooth and glistening throughout. Small, circular, yellowish areas were scattered throughout the head just below the cortical plate from which sections were obtained, as indicated in Figure 2.

The section shown in Figure 3 revealed normal bone with normal yellow bone mar-

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Sur la scoliose des nourrissons et des jeunes enfants. Rev. d'Orthop., XXIII, 19, 1936.

Personal letter, May 1938.

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## Correction

Dr. Sterling Bunnell of San Francisco has requested that we call attention to a correction in his article entitled "Opposition of the Thumb", published in *The Journal* for April 1938. Line three on page 281 should read: "In regard to tendons, the *flexor pollicis brevis* is excellent as it"; and line thirty-one on page 282 should read: "Another method is to detach the tendon of the *flexor pollicis brevis*".

# Current Literature

EXPERIENCE IN THE MANAGEMENT OF FRACTURES AND DISLOCATIONS (BASED ON AN ANALYSIS OF 4390 CASES). The Staff of the Fracture Service, Massachusetts General Hospital, Boston. Under the General Editorship of Philip D. Wilson, M D. Philadelphia, J. B. Lippincott Company, 1938. $15.00.

This treatise on the subject of fractures and dislocations is unusual in that it is based upon the study of actual cases and the analysis of the results of treatment. The material is from the Fracture Service of the Massachusetts General Hospital, which has a staff composed of skilled and experienced general and orthopaedic surgeons, who have devoted a large portion of their time to the conduct of this Service, and who have met together at frequent intervals to discuss and to decide upon not only the general treatment but also the management of special cases under their care. This Staff has also spent considerable time in following up the patients and in determining the end results. They have thus been able to check up on the relative efficiency of the different methods of treatment and to evaluate the results from the point of view of anatomical restoration, functional recovery, and working power. This book, then, represents the individual and collective experience of this group. It is edited by Dr. Philip Wilson of New York City, formerly a member of this Staff, with the members of this Service during the period 1923–1930 as collaborators.

The book is too comprehensive to discuss each subject in detail, but it is hoped that this collection of actual cases and their end results will be of practical assistance to physicians seeking the most effective treatment for similar cases.

This volume contains 1036 pages and 1419 illustrations and represents the observation of 3985 patients and 4390 fractures. Of this group, 1573 patients and 1937 fractures were treated in the wards of the Hospital, and 1192 of these patients (1511 injuries) were examined a year or more after injury. Each collaborator was assigned an anatomical region or type of fracture. The text is full, and the illustrations are numerous. Most of the illustrations are schematic diagrams or tracings of roentgenograms, which is a graphic and practical method of showing the type of fracture and the position of the fragments, and often demonstrates the distortion more clearly than the roentgenogram itself. The details of the technique of many of the operations are given, which should be appreciated, coming as it does from men of such experience, for this information is often lacking in editions of this kind. The reader has the advantage of being able to compare a large number of case notes with the text, thus permitting him to form an opinion of his own.

So many textbooks on this subject, as well as on other subjects, deal with the abstract types of injury, and the discussions of diagnosis and treatment are concerned with the application of general principles. Since this work gives the results of experience with actual cases, including the case histories and the discussion of the treatment, it makes available a large amount of unusually pertinent information for all who are dealing with these injuries.

THE RHEUMATIC DISEASES. A COURSE OF LECTURES ARRANGED BY THE MEDICAL STAFF OF THE ST. JOHN CLINIC AND INSTITUTE OF PHYSICAL MEDICINE. Edited by Sir Leonard Hill, M.B., LL.D., F.R.S., and Philip Ellman, M.D., M.R.C.P. With a Foreword by Sir Arthur MacNalty, K.C.B., M.D., F.R.C.P. Baltimore, William Wood & Co., 1938. $4.00.

This series of twenty post-graduate lectures, delivered at the St. John Clinic, should be read carefully by those interested in the rheumatic diseases, first, because of, rather than despite, the marked divergence of opinion expressed, and second, for the reason that

they make evident the great value of cooperation and teamwork in the study and treatment of a vital problem.

There are obvious shortcomings—such as variable classifications in the different lectures, strongly personal and theoretical viewpoints with lack of factual backing, and unmerited emphasis on some subject matter—but withal there is an obvious sincerity of purpose.

The etiological and clinical survey of Wilcox conforms to the classic researches of Poynton and Payne, which are the basic principles of the infective theory. The importance of the nasopharynx and intestinal tract as persistent foci of infection is justifiably stressed.

Fox's review of the social and economic aspects is effectively written and should be a spur to further concerted effort in the United States, where we have small right to be satisfied with our progress to date.

Classification, discussed by Ellman, is a moot subject as always, but one cannot help being in sympathy with his attempt at simplification. His chapter on drugs is fairly comprehensive, but seems to be overweighted with gold.

Findlay, at variance with some of the others, finds little to confirm the belief that acute rheumatic fever of childhood is allied to chronic rheumatic afflictions of later life. His discussion of the "mischief" is interestingly agnostic.

The lecture on pathology by Fisher is well illustrated and effective, even though he disregards bacterial invasion out of preference to the virus theory, which has so little to recommend it. His final chapter on orthopaedic cooperation is excellent and important.

Barwell rightly indicts the nose and throat and briefly defends the proper use of diathermy.

Oldershaw and Robinson convincingly present the pelvis as the most frequently overlooked focus of infection. The latter author also summarizes the signs and treatment of sciatica and brachial neuritis.

In his lecture on radiology, Calthorp seems to suggest the desirability of reading Gilbert Scott.

The influence of low-grade infection in the non-articular rheumatic afflictions is well outlined by Bach, and he also gives a fair appraisal of the value of hydrotherapy.

Gordon clearly differentiates between ankylosing arthritis of the spine, with its gloomy prognosis, and the more benign osteo-arthritic type. His chapter on fibrositis is an excellent presentation of a most frequently unrecognized condition.

Koerner and Poulton lay what many will consider undue stress on antistreptolysins, but they note a point well worth stressing,—namely, the probability that gout may have an infective background.

Taylor's physical basis of physical medicine is a lucid though somewhat technical presentation that should serve to clarify the rationale to many of us.

The chapter on physiological action by Hill is short and in part theoretical, but is an excellent summation of the subject.

Eidinow presents the indications for light therapy and the technique of treatment with ultra-violet rays in two separate lectures. Despite his obvious enthusiasm, he has presented his material with such fairness and clarity that its careful consideration should make the average worker in this field more effective.

KOLLATERALE ENTZÜNDUNGSZUSTÄNDE (SOG. AKUTE KNOCHENATROPHIE UND DYSTROPHIE DER GLIEDMASSEN) IN DER UNFALLHEILKUNDE [Collateral Inflammatory Conditions (So-Called Acute Bone Atrophy and Dystrophy of the Extremities) in Traumatic Surgery]. Dr. Paul Sudeck. (Beihefte zur *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, Heft 24.) Berlin, Julius Springer, 1938. 6.40 marks.

This monograph is written in further pursuit of the concepts advanced by Rieder and Sudeck that acute bone atrophy represents an inflammatory reaction of repair and

reconstruction, directed towards the formation of physiological bone structure, that it occurs in response to injury, and that it is applicable also to muscle and other tissues even at a distance from the site of injury. The rôle played by inactivity is discounted. If the injury is too severe or prolonged, regeneration is retarded, calcification is hindered, and the condition becomes a dystrophy; when the process of dystrophy becomes stationary, atrophy occurs. Sudeck summarizes his theory as follows: "We may therefore distinguish three fundamentally different stages, which for some time have been combined under the concept of acute (Sudeck's) bone atrophy: (1) inflammation (regarded as productive repair reaction); (2) dystrophy (chronic degenerative inflammation); and (3) atrophy (subsided inflammation)."

An attempt is made to allot symptoms and signs to these stages, as well as to subdivide the stage of dystrophy, but even Sudeck has difficulty in constructing categories and drawing distinctions among these stages. The factor of trauma and its repair is made too inclusive, and, in addition to overlooking other possible causes for late tissue changes and atrophy, leads to an open disregard for the element of inactivity, even though the latter is often undeniably implicated by the very evidence which is adduced to disprove it. The particulars which are sought to confirm the general proposition are often indefinite and contradictory.

The monograph includes eighteen clinical examples of the later course of injuries to the extremities. They are advanced as illustrative of the stages of inflammation, dystrophy, and atrophy, but are marred by this effort, as they do not necessarily provide evidence for Sudeck's theory. However, the monograph is of definite value in calling attention to the changes that may occur following injury to an extremity. The author has made many careful observations, which are useful guides to prognosis and to the sound lines of treatment which he recommends.

THE AMERICAN ILLUSTRATED MEDICAL DICTIONARY. W. A. Newman Dorland, A.M., M.D., F.A.C.S, with the collaboration of E. C. L. Miller, M.D. Ed. 18. Philadelphia and London, W. B. Saunders Company, 1938. Plain, $7.00; Thumb Indexed, $7.50.

During the past few years, the rapid developments in medicine, particularly in the field of research, and the elaboration of new methods and means of diagnosis, have brought about many changes in and additions to the medical nomenclature. The revision of some of the systems and the adoption of a more descriptive terminology, as, for instance, in the field of Anatomy, have also resulted in many changes. The medical public should be appreciative of the fact that the publishers of this book have recognized these changes at so early a date and have made available so quickly this revised edition.

The previous edition has been enlarged by over sixty pages and completely revised. The thoroughness of this revision can be realized from the fact that 3,000 new words have been defined, hundreds of which are not to be found in any other dictionary. As indicated in the Preface, the largest number of important additions and changes are in the fields of Endocrinology, Immunology, Pathology, Medical Chemistry, Clinical Medicine, Dentistry, and Biopsychology.

As those who are familiar with the previous editions know, in addition to the concise definitions of recognized medical terms, in many cases further clarified by illustrations, the book contains a wealth of descriptive material, as well as anatomical and clinical tables, chemical formulae, tests, methods of treatment, etc. The 283 portraits of distinguished medical and surgical men will be found an interesting addition to the purely technical data. The pronunciation, capitalization, and preferred spelling of each term are clearly indicated and the derivation given. The material is admirably arranged, affording quick and easy access to the reader.

At a time when so much is being added to the general medical knowledge and so many new terms are necessary to describe and discuss the medical problems of today, there is great need of a uniform nomenclature which would facilitate the exchange of ideas and encourage cooperation among the members of the medical profession, and to

this end the Eighteenth Edition of the American Illustrated Medical Dictionary will aid to an extent greater perhaps than any other one influence.

INNERE MEDIZIN IN DER CHIRURGIE. Doz. Dr. med. habil. H. Frh. v. Kress und Dr. med. W. Kittler. (Neue Deutsche Chirurgie, Bd. LIX.) Stuttgart, Ferdinand Enke, 1938. 11.80 marks.

The best reference book on medicine for the surgeon is obviously the standard medical textbook. To simplify medicine for the surgeon, or to present medical facts to him in a different way, would be to patronize his medical knowledge. However, there are certain fields of abnormal physiology which are peculiarly important to the surgeon, and which are justifiably discussed for his benefit. The present small volume does just this and serves as a supplement to the surgical textbook.

The interest of the authors is indicated by the fact that, of the 141 pages, 116 are devoted to pulmonary and circulatory disturbances. Particular attention is given to preoperative and postoperative conditions of the circulation, their diagnosis, prevention, and treatment. The differential diagnosis between collapse or shock and cardiac failure is discussed thoroughly from a modern viewpoint. The numerous conditions which may contribute to circulatory failure are considered separately and thoroughly. The treatment of collapse during anaesthesia, immediately postoperatively, and during the days subsequent to operation, is quite fully described.

Valuable and new to the average American physician is the discussion of the use of strophanthin in cardiac patients. The authors regard strophanthin as the most valuable remedy of the digitalis group. It is recommended in doses of 0.25 to 0.5 milligrams given intravenously daily, preferably in concentrated glucose solution, for the preoperative care of the cardiac patient. Not mentioned is the apparent contra-indication of strophanthin in the presence of digitalization and during the administration of calcium.

The short sections on hyperthyroidism are not of especial value to American physicians. That there is danger of producing or increasing hyperthyroidism by the use of iodine is not the experience of most observers in this country.

The care of the pneumonia patient is quite incompletely described, inasmuch as the use of serum and other valuable remedies, which have been elaborated in America in recent years, is omitted.

The preparation of the diabetic patient is simply and adequately told. The use of protamine insulin is not included. There is a short section on the treatment of patients with obstructive jaundice and its complications. The book closes with an excellent section on the treatment of disorders of sleep.

The book is written and arranged in readable fashion and can be strongly recommended for study.

OUTLINE OF ROENTGEN DIAGNOSIS. AN ORIENTATION IN THE BASIC PRINCIPLES OF DIAGNOSIS BY THE ROENTGEN METHOD. Leo G. Rigler, B.S., M.B., M.D. Atlas Edition. Philadelphia, J. B. Lippincott Company, 1938. $6.50.

This book is the outcome of the author's collection of material and the development of his method in preparation for teaching undergraduates. Repeated requests for a more complete exposition of his ideas and his material have resulted in this present publication.

The first section of the book consists of text only, in which the author considers the various affections according to the regional division of the body, and gives a brief description of the conditions and the roentgenographic findings, with their significance and interpretation.

The second part of the book is composed of illustrations, grouped in atlas fashion, to show the various affections which are taken up in the text of the first portion. These illustrations consist of roentgenograms, teaching drawings, and schematic diagrams. Since they have been used for teaching, they have been carefully selected, and their value has been proved. Each has a very complete legend, so that this portion of the book may be studied independently of the other.

A Student Edition without the atlas is also published, but the illustrations form a very important part of this work.

The book is comprehensive in its scope, including as it does the study of practically the entire body, and treating both the medical and surgical conditions. A generous portion is given to the consideration of orthopaedic and traumatic problems, the different stages in the course of bone diseases, and the types of fractures.

Since roentgenology is an adjunct to almost every field of medicine, this book will be useful to every physician and surgeon.

DIE KNOCHENGESCHWÜLSTE (Bone Tumors). Dr. med. habil. Hans Hellner. Berlin, Julius Springer, 1938. 49.80 marks.

This book is one of the best and clearest clinical expositions of the subject that has been written. It describes bone tumors from the standpoint of diagnosis and treatment. The classification of tumors adheres to that of the Registry of Bone Sarcoma of the American College of Surgeons and agrees with the histogenetic classification described in greater detail by Geschickter and Copeland. Hellner's book not only presents the most recent views on bone-tumor pathology, but shows that the modern classification of bone tumors is the most useful in determining the nature and treatment of neoplasms appearing in bone.

The book is profusely illustrated by photomicrographs and roentgenograms. Although the histological illustrations lack detail, the roentgenographic reproductions are good and many authors would do well to follow the excellent example of incorporating brief case histories in the legends to the illustrations.

Hellner covers all neoplasms affecting bone. There is a particularly good consideration of intracranial tumors, producing bone changes which are visible roentgenographically, as well as of maxillary tumors of dentigerous origin. Three much-discussed topics are relieved of their frequent ambiguity, and the author succeeds in reconciling prevailing and conflicting views on bone changes associated with hyperparathyroidism, giant-cell tumors, and Ewing's sarcoma.

"*Die Knochengeschwülste*" is the result of ten years' study of the bone-tumor material of Coenen's University Surgical Clinic of Münster, and is supported by a tremendous bibliography from which Hellner has derived and balanced the best opinions. The book leaves much unsaid, but all to the advantage of clarity and brevity. The translation of Hellner's book would greatly further the general understanding of a subject which heretofore has remained too closely within the confines of special study.

DER MENISKUSSCHADEN ALS KLINISCHES, ANATOMISCH-PATHOLOGISCHES UND UNFALLMEDIZINISCHES PROBLEM (Lesions of the Meniscus from the Point of View of the Clinical Aspects, Pathological Anatomy, and Traumatic Surgery). Dr. Hans Schaer. Leipzig, Georg Thieme, 1938. 11.80 marks

In spite of the voluminous existing literature on lesions of the meniscus, this 150-page monograph with fifty-five illustrations is somewhat different in its points of attack under the following three distinct headings: The Clinical Aspects, The Pathological Anatomy, and The Significance in Traumatic Surgery. The clinical consideration occupies more than half of the volume. It is concise, but complete and unbiased enough to be accepted as a text for students of any country. The mechanism of causation and types of injury are clearly shown. Modern are the uses of arthrography in the diagnosis and of elastic adhesive as a dressing. The details of the local operative technique and after-care, with a discussion of results, are presented.

The pathology—in particular, the histopathology—is well illustrated in color. Degenerative changes are significant, and are discussed again in the third chapter which considers the compensation angle. The relationship between lesions of the meniscus and degenerative arthrosis is well established. A comprehensive bibliography is appended.

THE SYNOVIAL MEMBRANE AND THE SYNOVIAL FLUID WITH SPECIAL REFERENCE TO ARTHRITIS AND INJURIES OF THE JOINTS. David H. Kling, M.D. Los Angeles, Medical Press, 1938. $5.00.

The physiology of the production and absorption of joint fluid in health and in disease and the characteristics of the fluid found in various pathological conditions are subjects which are being investigated intensively by various workers. Kling, in this interesting monograph, records the present state of our knowledge. Of definite value for the orthopaedic surgeon is the outline presented in Chapter XXII on "The Diagnostic Value of a Systematic Examination of Joint Effusions".

The literature has been carefully reviewed, and the findings of practically every investigation are recorded, but the author has made only a feeble attempt to assimilate and to systematize this complex mass of basic data.

DIE WERKSTOFFE IN DER ORTHOPÄDIE: IHRE EIGENSCHAFTEN, VERWENDUNG, UND PRÜFUNG (Materials in Orthopaedic Surgery: their Qualities, Application, and Examination). Dr. Hans Priess. Leipzig, Georg Thieme, 1938. 10.80 marks.

This book contains a wealth of technical description compiled by the head of the German government bureau in charge of the examination of materials required for the medical maintenance of war veterans. It describes and examines fundamental materials used in orthopaedic surgery—wood, leather, steel, light metals, cellulose derivatives, rubber compounds, cloth, felt, sewing materials, plaster, glass, porcelain, etc.—and a final chapter deals with the deleterious effect of body perspiration on many of these substances. Each material is introduced by establishing its place in government regulations and commerce, and it is then followed from natural or chemical origins through the processes of fabrication and modification to its ultimate orthopaedic uses. Each chapter is concluded by a description of the rigid analysis and testing to which the materials are subjected, and standards are derived from these examinations.

Priess's book is a compendium of technical detail, which provides the soundest standards for the materials used in orthopaedic practice. One might be inclined to dismiss it as a technical reference book, but Priess infuses it with remarkable life and readability. In his complete correlation of materials, with their ultimate application, he achieves a volume in which orthopaedic surgeons need not hesitate to seek answers to the many questions that it so completely discusses.

ON THE INJURIES TO THE LIGAMENTS OF THE KNEE JOINT. A CLINICAL STUDY. Ivar Palmer. (Acta Chirurgica Scandinavica, LXXXI, Supplementum LIII.) Stockholm, 1938.

From the ski runs of Stockholm came most of the fifty-eight cases which furnish the basis of this 275-page monograph. The anatomy is thoroughly reviewed and embellished by original illustrations. Clinical and cadaver studies serve to clarify the mechanism of various injuries. A plea is made for accurate diagnosis of recent injuries at a time when repair can be efficient. The methods of diagnosis and treatment of both acute and chronic lesions are clearly presented, with excellent drawings by the writer. Arthrography with a contrast medium furnishes roentgenograms of surprising clarity, which, for the most part, are well reproduced. Recent tears of the cruciate ligaments are usually repaired by suturing with black silk drawn through drill holes. Ruptured collateral ligaments occasionally require operation, as illustrated by several cases. The repair of chronic injuries is a large undertaking, and complete restitution cannot be expected. Only those knees with considerable disability should be operated upon according to the suggested methods.

No effort has been spared in preparing the material, which is well organized and most readable.

AKUTE GLIEDMASSENDYSTROPHIE IN IHRER BEDEUTUNG FÜR DIE BEHANDLUNGSMASSNAHMEN IN DER UNFALLCHIRURGIE (Acute Trophic Disturbances of the Extremities from the Point of View of Treatment in Traumatic Surgery). B. Karitzky. (Beihefte zur *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*. Heft 22.) Berlin, Julius Springer, 1938. 4.40 marks.

In this fifty-two page monograph, Karitsky presents a study of acute trophic disturbances of the extremities from the point of view of treatment in traumatic surgery. The work is based on observations and procedures in the *Chirurgische Universitätsklinik*, Freiburg in Breisgau.

The trophic manifestations are attributed to irritative phenomena associated with the shock of trauma, to the presence of infection, and to neurotic and thrombotic effects. Careful attention by the surgeon to each structure involved is necessary to avoid the dystrophy. Above all, the author stresses the fact that early anatomical restoration is a prerequisite of functional restoration. He also criticizes the manhandling of tissues by unnecessary postoperative manipulations. He makes the interesting observation that the dystrophic tissues are unsuited for transplantation because of their impaired vitality. Since the volume is essentially a detailed report of procedure, it is necessary to read the entire contents to obtain a complete understanding of the technique used in wound handling in the Freiburg Clinic.

RÉSULTATS ÉLOIGNÉ DU TRAITEMENT DES FRACTURES DE LA ROTULE PAR LE CERCLAGE (Late Results of Patellar Fractures Treated by Cerclage). Monroe Bertram Gall. Thèse de Strasbourg, 1938.

In a small monograph prepared for the Doctorate at the University of Strasbourg, the author briefly reviews the methods more commonly employed for the treatment of patellar fractures. At the Surgical Clinic B, the method of cerclage, with bronze aluminum wire, is used in all types of transverse fractures in which there is displacement of the fragments. Following the insertion of the wire, the leg is immobilized in extension for a period of six weeks. The wire is removed at the end of from two to three months.

Of sixty-three cases treated by this method during 1921 to 1937, only twenty-three were reexamined. Sixteen patients were considered to have excellent functional results, in that they complained of no pain and were able to flex the knee to 90 degrees or less. The results in five cases were classified as satisfactory. These patients complained of mild pain and could flex the knee no more than 45 degrees. In two cases ankylosis developed, due to patellofemoral fusion.

SPINA BIFIDA—PROGNOSE; ERBLICHKEIT (Spina Bifida—Prognosis; Transmissibility). Svend Hindse-Nielsen. *Acta Chirurgica Scandinavica*, LXXX, 525, 1938.

The detailed analysis of 357 cases of craniorachischisis which the writer collected from the Danish hospitals is presented in tabular form with illustrative cases. The prognosis is bad, with a tremendous mortality in the first six months in both the operated and non-operated cases. There were four patients with bilocular cysts, and several had multiple medullary lesions with localizing symptoms much higher than the tumor. Among the non-operated cases there was occasional secondary degeneration of the medulla during puberty, probably caused by fixation of the conus medullaris as in spina bifida occulta. The writer recommends operation as a rule only in cases of meningocele or myelocele with few symptoms, leaving those with syringomyelocele to their fate.

Delay in closure of the neural tube takes place before the third fetal week. A personal study of 124 families and a review of the literature suggests the existence of a complicated hereditary rule connected with a sex-determining factor. There is certainly a familial concentration. Family trees and tabular data are offered in an exhaustive discussion of the problem of genesis.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

SUBLUXATION OF THE HIP TREATED WITH THE STABILIZING OPERATION OF LANCE. Frederik Therkelsen. *Acta Orthopaedica Scandinavica*, IX, 1, 1938.

Out of sixty-eight hips operated upon in sixty-one patients, follow-up examinations were completed on sixty hips in fifty-five patients, one to nine years following the Lance shelf operation. In thirty-three, the results were good; in fourteen, improved; and in thirteen, unimproved, with occasional exaggeration of symptoms. The ages ranged from two and one-half to seventy years, which seemed to have little bearing on the end result. The limp and Trendelenburg's sign disappeared in only a few cases, but there was less pain and limp in most, and the stability and subjective improvement fully justify the procedure.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

FIVE CASES OF TUBERCULOSIS OF THE SYMPHYSIS PUBIS. Eiler Greger. *Acta Orthopaedica Scandinavica*, IX, 43, 1938.

With five of his own, the writer was able to collect one hundred and thirty cases of tuberculosis of the symphysis pubis. The lesion usually accompanied tuberculosis elsewhere in the body, in both sexes, and at ages ranging from three to seventy years. Indirect injury was a likely predisposing cause in some cases, but pregnancy played no rôle. Pain in the symphysis was frequently absent. Fatigue in the legs, limp, and pain in the hip were early symptoms. An abscess near the symphysis, on the medial aspect of the thigh, or near the anus, often brought the patient to the doctor.

X-rays taken in the prone position showed a "mouse-eaten" appearance of the bones, frequently with sequestrum formation. The horizontal rami of the pubic bones later appeared at different levels. The differential diagnosis was often confusing. Treatment was general with aspiration of abscesses and removal of sequestra. Good results with a bone graft are mentioned. This form of fixation was not tried by the writer, who relied on the support of leather or plaster. Two of the five patients died of multiple tuberculosis.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

EPIDERMOID CARCINOMA IN OSTEOMYELITIS: CASE REPORT. J. H. Harrison. *The American Journal of Cancer*, XXXII, 527, Apr. 1938.

The author presents a case of epidermoid carcinoma of the leg, developing on the basis of chronic osteomyelitis of the tibia of eighteen years' duration. Pathological fractures of the bone occurred twice within the years prior to the patient's admission with advanced local carcinoma. Mid-thigh amputation and mild prophylactic roentgen-ray treatment directed to the inguinal nodes apparently have brought about a cure.

In a brief review of the literature it is emphasized that these cases are rare and originate usually only after long-continued activity of the osteomyelitis. The tibia is the commonest site, and the malignancy is of low grade and shows no tendency to metastasize. The author concludes: "When epithelial cells during the process of regeneration are exposed to the products of chronic inflammatory exudate for many years, their normal repair is altered to an extent which may eventually result in neoplastic growth."

The report is illustrated with photographs, roentgenograms, and photomicrographs.
—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

AN EVALUATION OF EXCISION IN THE TREATMENT OF UNUNITED FRACTURE OF THE CARPAL SCAPHOID (NAVICULAR) BONE. Arthur J. Davidson and M. Thomas Horwitz. *Annals of Surgery*, CVIII, 291, Aug. 1938.

Despite the progress made in the treatment of ununited fractures of the carpal scaphoid, a small but definite percentage fail to unite. Many of these fractures are not recognized until irreparable damage has occurred.

The authors realize that good results have been attained in cases of delayed or early non-union by prolonged fixation in a non-padded plaster cast as recommended by Böhler; also by the method of multiple drilling and by the use of an autogenous bone peg.

They feel, however, that total excision still has a very definite place in the treatment of these cases and is the treatment of choice in irreducible fractures, in badly comminuted fractures of the scaphoid (especially those associated with other carpal injuries such as a dislocated semilunar bone), and in neglected cases of non-union with marked and irreparable degeneration of the fragments. In cases where early return to work is essential, and which show obvious non-union and persistent disability, they also advise total excision following a fair but not too prolonged conservative regimen.

They state that early excision will result in a normally functioning and painless wrist with little or no deformity. The efficiency of the procedure diminishes, however, with delay because of the development of arthritic and periarthritic changes in the wrist. They advise against partial excision, as the disability is liable to persist after the procedure.

The authors use a dorsal incision, two inches long, lateral and parallel to the tendon of the extensor pollicis longus. The wrist is immobilized from seven to ten days, and thereafter motion is encouraged.

They analyze eight cases, all in males between the ages of twenty-one and forty-nine years. Seven cases had total excision and one had partial excision. Results were very good or excellent in five cases, good in two cases, and poor in one case. The latter case was one of seven years' duration with marked osteo-arthritic changes.

The authors conclude that "total excision must be considered in the rational therapy of ununited fracture of the carpal scaphoid. . . . When utilized early before secondary arthritic and periarthritic changes take place, a very satisfactory result with regard to anatomic, functional and economic recovery may be anticipated."—*O. B. Bolibaugh, M.D., San Francisco, California.*

THE OSSEOUS SYSTEM IN HODGKIN'S DISEASE. Hyman S. Abrams. *Annals of Surgery*, CVIII, 296, Aug. 1938.

The author is of the opinion that the incidence of bone involvement in Hodgkin's disease is greater than is commonly believed. He was unable to find any comprehensive statistics on the subject. The terminology is confusing, as leukemia, lymphosarcoma, and Hodgkin's disease have all been classified as lymphoblastoma.

Some authors have reported an incidence of 10 per cent., while others believe that all cases have bone involvement at some time during the disease. Symmers found osseous changes in seven of his fifteen cases. Craver and Copeland reported an involvement of 15.7 per cent. in 172 patients with Hodgkin's disease.

The author discusses ten consecutive unselected cases referred to the Radiation Therapy Department of the Brooklyn Cancer Institute with a diagnosis of Hodgkin's disease. Of these, eight proved to be Hodgkin's disease. Four of these patients had typical bone lesions, two showed changes characteristic of Hodgkin's disease, and the other two showed no bone changes.

Some authors have reported osseous invasion before lymph-node involvement, which raises the question of where primary involvement occurs.

Lesions are usually multiple and occur, in order of frequency, in the spine, pelvis, sternum, ribs, skull, and extremities. The roentgenographic appearance may be osteolytic, osteoplastic, or a combination of the two. Hodgkin's disease of the bone may be confused with changes due to carcinoma, multiple myeloma, chronic osteomyelitis, Ewing's tumor, hypernephroma, tuberculosis, leukemia, lymphosarcoma, and cysts. Symptoms depend upon the location of the lesion and the degree of functional impairment, and therefore vary from no pain to excruciating pain, marked impairment of function, pathological fractures, etc.

Roentgenotherapy offers palliation, remission, and retardation of the progress of the disease in many cases.

The author presents briefly the history of two cases. He emphasizes the importance of early diagnosis and treatment of Hodgkin's disease of the osseous system. The possi-

bility of Hodgkin's disease should always be considered in cases showing atypical bone lesions and unusual clinical manifestations.—*O. B. Bolibaugh, M.D., San Francisco, California.*

SCIATICA AND ITS TREATMENT. B. L. Chopra. *The Antiseptic*, XXXV, 329, Apr. 1938.

In discussing the treatment of sciatica, the author recognzies the importance of finding and eliminating focal infections in the teeth, the nose, and the tonsils. In addition to other measures, he finds the most useful form of treatment to be that of massive injections of five ounces of sterile, normal salt solution in the region of the sciatic nerve at the site of its exit from the pelvis. Three such injections are given on alternate days. Relief from pain was general and permanent cure was effected in a number of cases.—*Robert M. Green, M.D., Boston, Massachusetts.*

TUMORS OF THE SPINE. WITH A CONSIDERATION OF EWING'S SARCOMA. Robert R. Rix and Charles F. Geschickter. *Archives of Surgery*, XXXVI, 899, June 1938.

Two hundred and ninety-one tumors affecting the bone structure of the spinal column, available for study in the Surgical Pathological Laboratory of the Johns Hopkins Hospital, are analyzed. All of these tumors were demonstrable roentgenographically.

In the order of their frequency they are: metastatic carcinoma, primary tumors of the spinal column, glial tumors, tumors of the neural sheath of the spinal cord, tumors of generalized distribution, tumors of the sympathetic nervous system, and tumors of teratological origin.

The metastatic carcinoma is the most common neoplasm of the vertebral column and usually originates either in the breast, when it is multiple and destructive, or in the prostate, when it usually involves the lower spine and has osteogenetic characteristics.

Of the primary tumors of the spine, the malignant sarcomata are found to include chondrosarcoma, osteolytic sarcoma, and sclerosing sarcoma. These may be secondary to multiple exostoses or to Paget's disease. Chordoma affects the upper and the lower ends of the spine of the adult and produces a destructive lesion.

The benign growths include the giant-cell tumor and the osteochondroma. Hemangioma is rare.

There were twelve neuroblastic tumors. No typical Ewing's sarcoma of the spine was found.

The differential diagnosis is discussed, and there are numerous illustrations.—*I. William Nachlas, M.D., Baltimore, Maryland.*

SPONDYLOLISTHESIS. TREATMENT BY ANTERIOR BONE GRAFT. Kellogg Speed. *Archives of Surgery*, XXXVII, 175, August 1938.

Speed analyzes the causes of anterior slipping of the body of the vertebra in spondylolisthesis and finds that the condition is usually associated with a defect in the bony structure of the neural arch. Because of this, a fusion of the spine through the spinous processes is not enough to prevent the anterior slipping of the body. He quotes statistics on the end results of the posterior spine fusion to substantiate this. It is his belief that the solution to the problem is a fusion through an anterior approach, designed to anchor the body of the slipping vertebra. He describes his technique to accomplish this and reports a case in which he performed this operation.—*I. Willam Nachlas, M.D., Baltimore, Maryland.*

FRATTURA-LUSSAZIONE TOTALE BILATERALE SIMMETRICA DELLA ARTICOLAZIONE DI LISFRANC (Bilateral Symmetrical Complete Fracture-Dislocation of Lisfranc's Joint). Antonio Moratti. *Archivio di Ortopedia*, LIII, 505, 1937.

In this article, Moratti reports a case of this unusual injury. A woman, twenty-one

years old, jumped from a balcony about five and one-half meters high. She landed on her feet, fell, and could not get up again. Roentgenographic examination revealed lateral displacement of the metatarsal bones, the first and second being displaced dorsally, also. Attempts at closed reduction being unsuccessful, open reduction was performed and the joint between the first metatarsal bone and the cuneiform bone was fused. Excellent clinical results were obtained.—*Ernst Freund, M.D., Los Angeles, California.*

La cura ortopedico-chirurgica della poliartrite cronica primitiva (Treatment by Orthopaedic Surgery of Chronic Primary Polyarthritis). Riccardo Galeazzi. *Archivio di Ortopedia*, LIII, 521, 1937.

In this article, Prof. Galeazzi gives a general review of the subject as presented at the meeting of the Italian Committee for the Control of Rheumatism. The great social importance of chronic infectious polyarthritis is emphasized inasmuch as it forms statistically a high percentage among the causes of invalidism. The classification into an infectious inflammatory type and a degenerative form is maintained. The idea of Oppel that primary chronic polyarthritis is of endocrine origin, due to a disturbed function of the parathyroid glands, and that it can be cured by a partial removal of these glands, has not been confirmed by the results. As long as the real cause of infectious polyarthritis is unknown, orthopaedic surgery cannot lead to radical cure, but is of great help in preserving, improving, and restoring joint motion. It has to deal with the different manifestations of the disease,—pain, circulatory disturbances, contractures, joint effusions, and alteration of joint motion. The inflammatory nature of the disease makes it necessary that orthopaedic treatment be applied very carefully and gradually, because there exists constantly the danger of exacerbation. Conservative treatment is preferable to surgery. A complete synovectomy is a very reasonable form of surgical intervention. Other operations, such as arthroplasty or arthrodesis, should be done only after a wise selection of cases. Periarterial sympathectomy and ganglionectomy influence only the circulatory disturbances and are not of lasting effect.—*Ernst Freund, M.D., Los Angeles, California.*

Semeiologia clinica della claudicazione (Clinical Symptomatology of Limping). Antonio Poli. *Archivio di Ortopedia*, LIII, 543, 1937.

This paper, prepared as a report for the twenty-eighth Congress of the Italian Society of Orthopaedic Surgery and Traumatology, gives a careful review of the literature with discussion of the normal gait and its analysis, including Scherb's and Schwartz's experiments. The second part is devoted to the pathological gait and the different forms of limping attributed to various factors, among which are mentioned: pain affecting the lower extremities or the trunk; difference in length of the lower extremities—either simple, due to fractures of the diaphysis or to hypoplasia, or complicated, as by congenital dislocation of the hip, coxa vara, coxa valga, etc.; alteration of joint motion; stiffness or complete ankylosis; alteration of the muscular apparatus; infantile paralysis; spastic paralysis; Little's disease, etc. The paper represents a good review without adding any original thought.—*Ernst Freund, M.D., Los Angeles, California.*

The Modern Treatment and Results of Treatment of Fractures of the Neck of the Femur. Ernest W. Hey Groves. *British Medical Journal*, II, 359, 1937.

The Smith-Petersen nail is designated as "a wonderful example of the triumph of practice over theory", and the rapid adoption of this method in the treatment of femoral-neck fractures is due to the "very quick, immediate restoration of function which it affords". In comparison with the original Whitman procedure, which resulted in bony union in from 50 to 60 per cent. of the cases, the author believes that the intelligent use of the Smith-Petersen nail will bring success in 75 per cent. of these cases.

In discussing methods of application of the nail, Hey Groves believes that neither the open operation nor blind insertion of the nail over wire guides is justified in old and

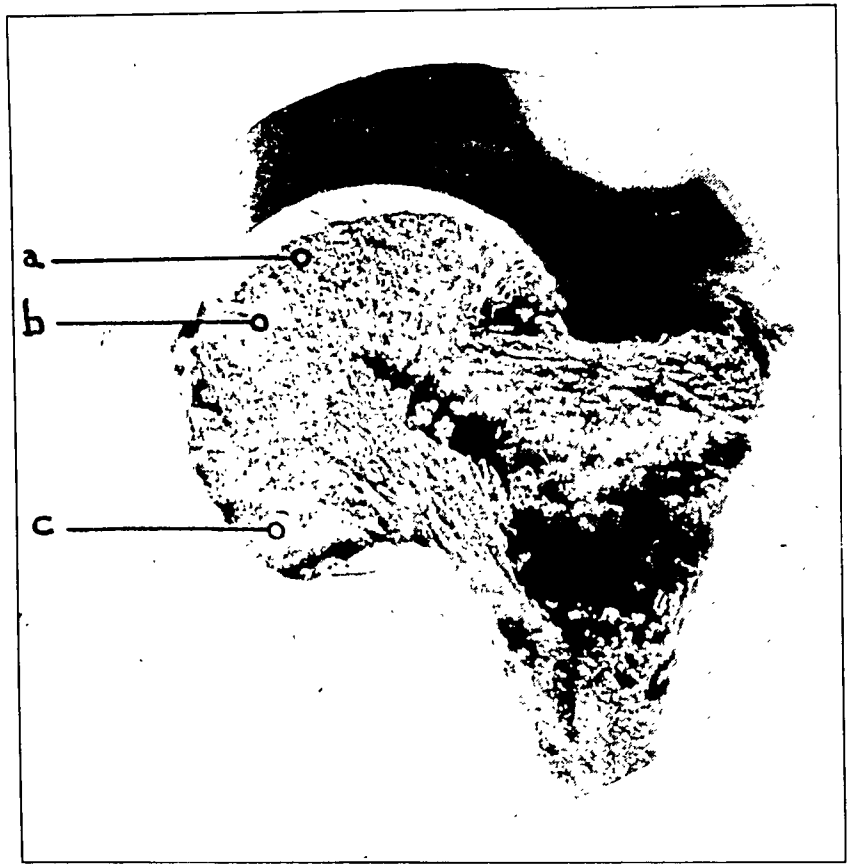



FIG. 2

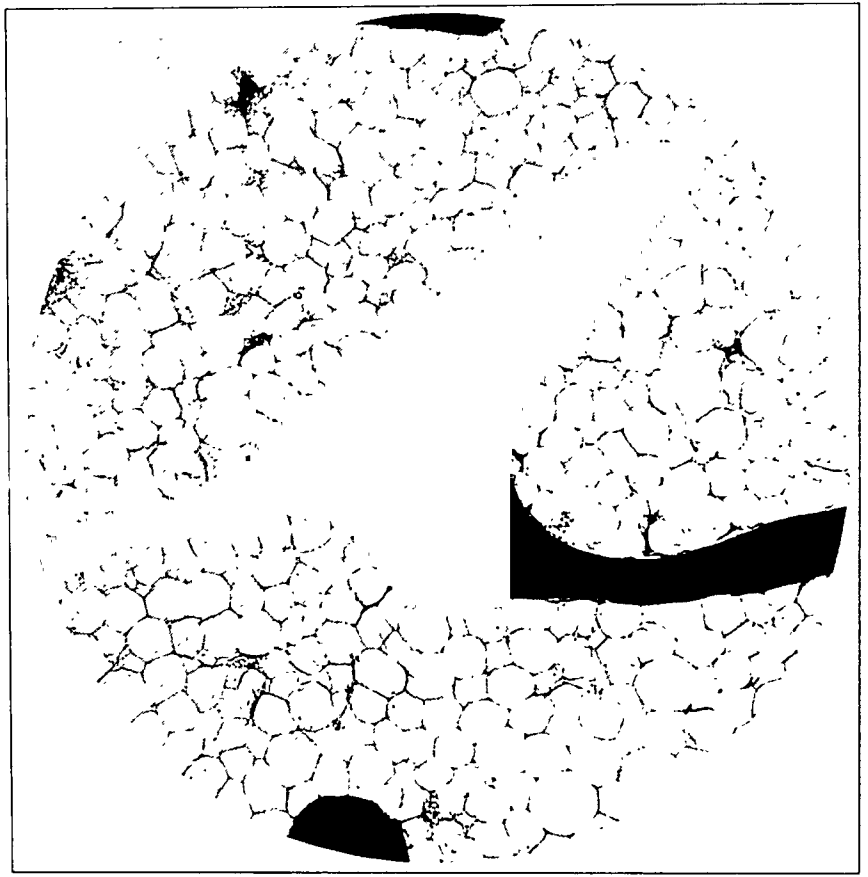


FIG. 3

Fig. 2: Proximal fragment showing head and neck of the femur with extensive endosteal loss in neck and scattered focal necrotic areas in head. The letters *a*, *b*, and *c* indicate the areas from which microscopic sections were taken.

Fig. 3: Photomicrograph showing normal marrow and trabeculae. (See Figure 2, *a*.)

lesion seemed to be in the metaphyseal extremity of the diaphysis. As in acute osteomyelitis, the infecting organism found in the majority of cases was staphylococcus aureus. There is perhaps no other lesion in which the clinical history of the patient is more helpful in diagnosis. The clinical history indicates the age of the lesion and the existence of any previous septic focus or infection likely to be associated with bone abscess. Such information is invaluable in view of the fact that lesions of a widely different significance produce a rather similar appearance in the roentgenogram. Such lesions are tuberculous abscess, gumma, simple bone cyst, sarcoma, and endothelioma. In the case of a tuberculous abscess, the process does not appear to be checked by the growth cartilage at the metaphysis and prevented from invading the epiphysis, as is the usual feature of the staphylococcal abscess. Gumma of the bone is usually identified by the massive reaction which it produces in the adjacent bone. The simple bone cyst expands the bone, and its boundary is but a thin wall of bone, which appears to be yielding to pressure of its contents. There is usually no evidence of new periosteal bone. There is a type of sarcoma which starts in the medulla by destroying adjacent bone and by producing an abscess-like cavity. Its boundaries are not clearly defined, as in the case of the simple bone cyst. Endothelial myeloma of the bone occurs at about the same age periods as does the chronic bone abscess. Serial roentgenograms of the lesion will usually suffice for identification.—*James W. Toumey, Jr., M.D., Boston, Massachusetts.*

INJURIES TO THE ELBOW-JOINT. S. L. Higgs. *British Medical Journal*, II, 189, July 23, 1938.

*Tennis Elbow:* The diagnosis is easily made if typical pain occurs when the wrist is actively extended against resistance and the forearm is supinated. With maintenance of active extension, the pain can be localized in one or more of three usual situations, all beneath the common origin of the extensor-supinator group of muscles. The first and most usual is over the radiohumeral joint; the second, slightly higher up in the region of the lateral epicondyle; and the third and least frequent, more forward between the bulky part of the muscle origin. Treatment at the onset is simple physiotherapy, rest, heat, and avoidance of painful motion. In the early chronic stage, which may last a year or more, certain cure can be obtained by operation. A slightly curved incision, four inches long, is made on the outer side of the elbow behind the lateral epicondyle; the muscles of the extensor-supinator group are reflected from the epicondyle and capsule of the radiohumeral joint. Definite pathological tissue is excised, and the muscles are resutured. The arm is usually strong and comfortable by the end of from two to three weeks. Manipulation is effective in the late chronic stage. The author advocates the Mills method, and thinks it can be done without an anaesthetic, although with local injection of novocain it is much less painful.

*Dislocations and Sprains:* Posterior dislocation is the most common, and diagnosis is obvious. In such cases, reduction is easy and is obtained by steady traction on the forearm in the line of the limb. In older dislocations, hyperextension of the joint will lever the coronoid process over the humeral surface. The arm is then put up in fairly full flexion, and is carefully observed in case swelling should develop. The author feels that it is better to immobilize the elbow in a molded posterior slab of plaster for a fortnight than to attempt early active motion. He also emphasizes the fact that the resumption of the range of motion and activity of the arm should be left to the patient's own efforts. Massage, stretching, and forceful measures of any kind are not indicated. If myositis ossificans develops, complete fixation of the joint for a long period is essential; immobilization is again obtained by the posterior plaster splint as described. In those cases in which a definite bone block exists after the process has become quiescent, the growth is removed by operation. Treatment of old dislocations is similar to that described for the more recent cases. The author feels that open operation is rarely either necessary or satisfactory, as it entails too much injury to the soft parts and subsequent stiffness.—*G. E. Haggart, M.D., Boston, Massachusetts.*

feeble patients—the individuals who constitute the real problem in this fracture. Instead, blind insertion of the nail with the help of a mechanical director is advocated. This director consists of two prongs,—one inserted into the mid-femoral head; the other, into the base of the femoral neck. A drill can thus be passed accurately into the bone in the true axis of the femoral neck. The operation is bloodless; it is performed under gas-oxygen anaesthesia; and it requires from ten to fifteen minutes. The nail is removed in three months.

In late cases with definite non-union, the author favors a bifurcation osteotomy. This procedure is simple and involves no shock or hemorrhage, and the Y-shaped upper end of the femur will support body weight from the lower margin of the acetabulum while abduction of the leg is substituted for adduction, and thus leg shortening is reduced.—*G. E. Haggart, M.D., Boston, Massachusetts.*

INJURIES IN THE REGION OF THE SHOULDER JOINT. I. CAPSULE AND TENDON INJURIES. R. Watson-Jones. *British Medical Journal*, II, 29, July 2, 1938.

The author notes that the majority of painful shoulders are due to minor injuries of the supraspinatus tendon, and that complete rupture, although rarely diagnosed, is a common and disabling industrial accident. Dramatic results may be secured in this condition by injecting 2-per-cent. novocain into the painful region. If the symptoms are incompletely relieved by injection, diathermy and radiant heat are of value in encouraging the necessary revascularization. Small calcareous deposits in this region should be treated conservatively by diathermy, radiant heat, and massage. Large deposits should be removed surgically. Most cases of complete rupture of the supraspinatus tendon can be successfully treated conservatively by maintaining the arm in 90 degrees of abduction and in external rotation upon a plank for at least eight weeks. In cases where periarticular adhesions have formed, manipulation under anaesthesia should not be used except as a last resort. Much can be gained by exercises without forcible movement.—*James W. Toumey, Jr., M.D., Boston, Massachusetts.*

INJURIES IN THE REGION OF THE SHOULDER JOINT. II. BONE AND JOINT INJURIES. R. Watson-Jones. *British Medical Journal*, II, 80, July 9, 1938.

For ordinary fractures of the clavicle, the author employs the figure-of-eight bandage. The finger, wrist, and elbow joints must be exercised frequently from the first day. The author describes a simple form of strapping for an acromioclavicular dislocation, which gives excellent results and which makes operative measures unnecessary, even when the ligaments between the coracoid and the clavicle are torn. In dislocations of the shoulder with paralysis of the deltoid, this muscle must be relaxed by abducting the shoulder in a frame. In the after-treatment of shoulder dislocation, passive stretching and manipulation under anaesthesia should be rigidly avoided.

In cases of contusion and fracture of the neck of the humerus, complete immobilization is not necessary. The limb should be supported in a sling for from two to three weeks. It is a serious mistake to believe that every fracture of the upper end of the humerus should be treated in abduction. In abduction fractures, the shaft is already abducted on the head, and an abduction frame will perpetuate or increase this displacement. As a rule, the displacement is not of a serious degree and does not require manipulation. The limb is supported in a sling in the adducted position by the side of the trunk.—*James W. Toumey, Jr., M.D., Boston, Massachusetts.*

BRODIE'S ABSCESS AND ITS DIFFERENTIAL DIAGNOSIS. James F. Brailsford. *British Medical Journal*, II, 119, July 16, 1938.

The author studied sixty-two cases of Brodie's abscess and found that the lesion occurred twice as often in the male as in the female. The majority occurred in the age period between eleven and thirty years. Over one-third of the total number of abscesses were found in the lower end of the tibia. Except in a very few instances, the primary

The sex incidence showed a preponderance of males, which is contrary to the usual findings, since most authors state that there is a definite preponderance of females.

All of the cases reported occurred in the jaw, and, of the twenty-six cases, twenty-two occurred in the mandible and four in the maxilla.

The authors agree with previous writers that the tumor is of very slow growth, in one case being of fifty-one years' duration. The two different types of adamantinoma, cystic and solid, are discussed, and the point made that practically all these tumors are polycystic in character, there having been only one solid tumor among the cases reported.

The authors reaffirm the etiology of adamantinoma as arising from the peridental epithelial debris of Malassez, and believe that trauma, infection, or continued irritation are contributory factors in stimulating tumor growth. They do not discuss the histogenesis or pathology of the tumor.

The question of the malignancy of these tumors is also considered, and the series of cases reported indicates, as do all previous reports, that the adamantinoma is locally malignant and exhibits a definite tendency to local infiltration and recurrence. These tumors, in the experience of the authors, metastasize rarely, if ever, and none of the cases studied showed any evidence of metastases.

The diagnosis of adamantinoma of the jaw is sometimes difficult, but usually can be made by the following findings: a slowly growing symptomless tumor with an onset of toothache and local pain which disappears later. This history plus the good general condition of the patient, the location of the tumor, the absence of metastases, and the roentgenological picture of a central destructive tumor without peridental reaction, help to make the diagnosis. Differential diagnosis excluded giant-cell tumor, central fibroma, dentigerous cyst, dental-root cyst, malignant tumors, and osteomyelitis. In the opinion of the authors all central tumors of the jaws should be considered as adamantinomata until proved otherwise.

The treatment of adamantinoma should be mainly surgical, and marked emphasis is placed upon the importance of radical surgery. Radiation has not been successful among Chinese patients, and the tumor is known to be essentially radioresistant. Complete excision of the tumor with wide resection of the surrounding bone is the treatment which in their opinion yields the best results.

So far as end results are concerned, the authors state that they have not known of a single recurrence of the tumor among their cases and they believe that, on account of the low degree of malignancy of the tumor, radical excision should be followed by a high percentage of satisfactory results. Sufficient time had not elapsed to allow them to give absolute end results.—*George Van Gorder, M.D., Boston, Massachusetts.*

THE ORTHOPAEDIC TREATMENT OF POLIOMYELITIS INVOLVING THE SOFT PARTS. F. Raszeja. *Chirurgja Narzadów Ruchi i Orthopedja Polska*, XI, 35, 1938.

This is an extensive article describing the method of treatment used by the author in eighty-two cases in the past five years. Paralysis of the lower extremity predominated; the upper extremity was affected in a small number of cases. The article is divided into six sections dealing with statistics, conservative treatment at the onset, operations on the nerves, tenotomies, tenodeses, and fasciodeses. In the last two parts the various tenoplastic operations are considered. The author does not perform important tenoplastic operations on children younger than five years. Tenotomies and tendon lengthening, or fasciodeses, are performed in this group. The author gives a historical and bibliographical review of the literature on tenoplastic operations, with a biological exposition of the entire problem. The value of tendon transplantation is found to be very limited. The various bone operations for stabilization of the foot are used in cases where the transplantations are not sufficient. Lange's operation for gluteus weakness was used successfully in five cases. In the lower extremity the author reports an average of 30 to 40 per cent. improvement. He finds it difficult to replace the function of the deltoid.—*Emanuel Kaplan, M.D., New York, N. Y.*

VUE D'ENSEMBLE SUR LE TRAITEMENT CHIRURGICAL DE LA TUBERCULOSE DU PIED ET DU COUP-DE-PIED. Jacques Calvé. *Bulletin de la Société Belge d'Orthopédie, et de Chirurgie de l'Appareil Moteur*, X, 175, 1938.

Calvé states that tuberculous infection accentuates the anatomical differences between the foot of an adult and of a child. In small children the great amount of cartilage surrounding the bony nucleus of the tarsal bone preserves the form of the bone and protects the articulations from infection.

In the child, healing may occur or a fistula may develop. A minimum of two years is required for healing. During this period there should be complete immobilization and no attempt at standing. If healing is long delayed, in tibiotarsal infection, one may perform an astragalectomy. Where secondary infection has occurred, adequate drainage is the first essential. Astragalectomy is advised for drainage in the posterior part of the foot. For the distal tarsal bones, bilateral drainage is advocated with resection of bone if necessary. Often healing is surprisingly good. The shape of the foot should be preserved if possible. Amputation should never be performed in children. Constant watch must be kept to prevent severe deformity.

In a fair number of adults, healing occurs after prolonged immobilization. Where healing does not occur and secondary infection intervenes, amputation of the foot offers the best chance of cure. Resections and astragalectomy should not be performed in adults.—*John G. Kuhns, M.D., Boston, Massachusetts.*

ANOMALIES OF THE SPINE. Wilbur Bailey and Ray A. Carter. *California and Western Medicine*, XLIX, 46, July 1938.

The authors found that 67 per cent. of spines show anomalies. A detailed discussion of the development of the spine and the origin of anomalies is given. Since the spine is very complicated, the anomalies are exceedingly variable, and involve all the different anatomical structures. These, as well as the persistent epiphyses of the vertebral processes, often have to be differentiated from fractures. There are certain features, such as location and character of the borders of the separation, which serve to make the differentiation evident. Abnormal fusion of vertebrae or hemivertebrae and fusion of spinous processes and even of bodies of vertebrae are seen. One is attracted by the frequency of anomalies in the transitional vertebrae in the cervicothoracic, thoracolumbar, and sacrolumbar areas. The so-called sacralization of the lateral processes of the fifth lumbar vertebra is seen, though not so often as is reported.

As to symptoms arising from these anomalies, such as cervical ribs and variations in the fifth lumbar vertebra, the authors question the prevalent belief that they are the causes of pain and disability, and quote from a report by Dr. Bohart of the Belt Railway Company of Chicago, that almost no back symptoms could be attributed to vertebral anomalies. The authors found that only about once in ten cases, where symptoms indicated a cervical-rib involvement, did they find one present. Lumbar ribs occur in 10 per cent. of all cases and are without symptoms.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

ADAMANTINOMA. A CLINICAL STUDY OF TWENTY-SIX CASES. H. T. Kimm and A. F. Baranoff. *The Chinese Medical Journal*, LIII, 1, 1938.

The authors discuss the incidence, etiology, diagnosis, treatment, and end results of twenty-six cases of adamantinoma of the jaw, which were seen in the Surgical Clinic of the Peiping Union Medical College Hospital, Peiping, China. Out of a total number of 350 tumors of the jaw that were observed, the incidence of adamantinoma was approximately 7.4 per cent.

Among the Chinese, these tumors were most frequently seen in individuals between the ages of thirty and thirty-five years, although the age incidence may range between early childhood and old age.

bipartite vertebral body with its bilateral ossification centers has a similar mode of origin, except that the vertebral bodies are in closer approximation, thereby destroying or making it difficult to identify the two notochord halves.

The author discards the widely held view that the binucleate vertebral body is due to bilateral deposit of the cartilaginous and osseous centers.—*Harold Unger, M.D., Iowa City, Iowa.*

THE INDUSTRIAL PHYSICIANS AND SURGEONS. *Industrial Medicine*, VII, 367, July 1938.

This is a comprehensive report of the Twenty-Third Annual Meeting of the American Association of Industrial Physicians and Surgeons and the Second Midwest Conference on Occupational Diseases, held in Chicago from June 6 to 9, 1938. The scientific program for the four days is given, and the excellence of the papers is stressed. Thirteen of the thirty-five papers which were presented are included in the same issue of *Industrial Medicine*, and the remainder will be published in the August and September numbers.

IMPORTANCE OF RESTORATION OF BLOOD SUPPLY IN FRACTURES OF NECK OF FEMUR. Fred H. Albee. *Journal of the American Medical Association*, CX, 2044, June 18, 1938.

The author believes that the possibility of an inadequate blood supply to the femoral head makes the treatment of subcapital or central fractures a special problem. Even though union of the fracture might be obtained, aseptic necrosis of the head might follow.

Since subcapital or central fractures may be wholly intra-articular, the only blood supply available for the head is through the ligamentum teres. Wolcott found in a study of cadavera that in 15 per cent. the ligamentum teres did not have vessels of sufficient size for the injection of mercury.

The author has performed 413 reconstruction operations for non-union of and/or absorption of the femoral neck. In more than 70 per cent. of the cases all ligamentous tissue appeared to have been avulsed from the cotyloid notch. In only two cases was the ligamentum teres found to be intact. It is believed that the rotation of the femoral head, incidental to the femoral-neck fracture, tears or avulses the ligamentum teres. If this ligament remains intact, as in primary impacted cases, it will continue as a source of blood supply to the head. The author feels that the intactness of the ligamentum teres is the determining factor in cases of non-union.

In partial or complete extracapsular fractures, the fragment is so long that it cannot be rotated under the rim of the acetabulum, thereby preserving the ligamentum teres. However, in these fractures the adherent soft structures convey blood to both sides of the fracture site. Thus the prognosis for a satisfactory result is good.

For internal fixation, the autogenous bone-graft peg is most effective. The author has previously reported successful results in 94 per cent. of his cases. In three cases the graft bridged a hiatus of from one-half to two-thirds of an inch between the fragments. The graft carries blood to the anaemic femoral head, furnishes adequate immobilization, and brings an osteogenic, callus-forming material to the fracture junction. Whether the bone-graft-peg operation should be employed as the primary treatment in subcapital or central fractures is for the patient and the surgeon to decide. It should, however, be used in this type of fracture at the earliest signs of non-union.—*H. M. Childress, M.D., Dallas, Texas.*

THE CARE AND TREATMENT OF CEREBRAL PALSIES. Winthrop Morgan Phelps. *Journal of the American Medical Association*, CXI, 1, July 2, 1938.

Before considering the care of cerebral palsies, it is necessary first to determine the exact aim in treatment. The gait of the child and his emotional behavior are both im-

CONSIDERAZIONI CLINICHE SULLA FRATTURA DA STRAPPAMENTO DELLA SPINA ILIACA ANTERIORE SUPERIORE (Clinical Considerations of Avulsion Fracture of the Anterior Superior Iliac Spine). Andrea Padula. *La Chirurgia degli Organi di Movimento*, XXIII, 69, 1937.

Three cases of this type of fracture in young athletes are reported. In two cases the injury was sustained when the patients were kicking soccer balls, and in the third case the patient was injured in starting a foot race. The mechanism of the avulsion is not the same in all cases. When the sartorius and tensor fasciae latae are strained in stabilizing the pelvis while the opposite foot is off the ground (as in kicking a ball), they may pull off the spine, and, with the leg in internal rotation (while kicking the ball), avulsion of the spine on the side of the kicking leg results.

Localized tenderness and inability to flex the leg or trunk or to lower the knee when the heel on the affected side was placed on the opposite knee were symptoms in all cases.

Simple immobilization with an adhesive belt, five centimeters wide, about the pelvis, resulted in marked improvement in from three to six days, with recovery from symptoms in a month. Check-up roentgenograms, taken eight and twelve months after injury, showed fusion of the anterior superior spine in two cases.—*A. W. Ciani, M.D., Iowa City, Iowa.*

SCIATICA PARALIZZANTE DA ERNIA POSTERIORE DI UN DISCO LOMBARE DEGENERATO (Paralyzing Sciatica from Posterior Herniation of a Degenerated Lumbar Intervertebral Disc). M. Paltrinieri. *La Chirurgia degli Organi di Movimento*, XXIII, 97, 1937.

The author reports the case of a woman, fifty-three years of age, who had complained of intermittent pain along the course of the left sciatic nerve for ten years. Following an acute exacerbation, foot-drop developed. Studies revealed narrowing of the disc between the fourth and fifth lumbar vertebrae and compression of the lipiodol column at this level. Spinal-fluid findings were negative. The patient refused surgery, and the case is reported merely to emphasize that one should not be satisfied with a simple diagnosis of sciatica, but should investigate every such case thoroughly.

Anatomical researches by Andrae showed herniated discs in 15.2 per cent. of 368 spinal columns. These were usually in individuals between the ages of fifty and eighty, and very rarely under thirty. According to Alajouanine and Petit-Dutaillis, herniation may depend on trauma or previous disc changes. If trauma is mild or absent, as in the case presented, it is fair to assume that some degenerative changes were present in the disc prior to herniation. According to certain authors, involutional changes in the disc begin in the third or fourth decade of life, and associated degenerative changes favor posterior herniation of the disc. Herniae found by anatomists usually present zones of degeneration. In fact, Dandy, Bucy, and the author support the theory that already existing disc changes invariably precede herniation.—*A. W. Ciani, M.D., Iowa City, Iowa.*

ZUR PATHOLOGIE DER BILATERALEN WIRBELKÖRPERFEHLBILDUNGEN UND ZUR NORMALEN ENTWICKLUNG DER WIRBELKÖRPER (The Pathology of the Development of Bilateral Defects in Vertebral Bodies). Karl Hartmann. *Fortschritte auf dem Gebiete der Röntgenstrahlen*, LV, 531, 1937.

There are two types of anomalies with bilateral developmental defects in vertebral bodies: (1) the formation of a complete gap in a vertebral body, or an anterior spina bifida; (2) the presence of two distinct ossification nuclei in a vertebral body, or bipartite vertebral body.

In the anterior spina bifida, there exists a paired notochord separated by a gap. Each half of the vertebral body is lateral to its respective notochord. The notochordal rudiments fail to unite and an anterior spina bifida results. The author believes that the

accurately speaking, is diplegia associated with difficult or abnormal birth. Birth trauma, however, is not necessarily a factor in diplegia.

The etiological factors, as classified by Hutinel and Babonneix, are given under the headings of causes operating:

Before conception:

Toxins, infections, neuropathic heredity, and consanguinity.

During pregnancy:

Intoxication, primary degeneration, gross developmental defects, and lues.

At delivery:

Premature birth, difficult delivery at term, asphyxia, anoxaemia, and air embolism.

During the first few months of life:

Acute infectious diseases.

In the first group of causal factors, alcoholism is the only established toxin, whereas syphilis is the most common infection. Heredity may be a cause but consanguinity is not acceptable as a factor.

Intoxications of pregnancy may make the blood vessels of the foetal brain vulnerable to rupture, may produce premature birth, or may cause degenerative brain lesions. However, a primary arrest or a developmental defect of the brain, which is associated with spasticity, is difficult to explain on a basis of trauma or vascular accident.

Premature birth may be a causative factor of Little's disease, but is not inseparably connected with the condition. It is reasonable to believe that the same condition produces both the prematurity and the congenital muscle rigidity. Trauma to the brain at birth is common and there is a difference of opinion as to the relationship of brain hemorrhage at birth to Little's disease. Asphyxia and anoxaemia are closely associated with this hemorrhage and all three conditions may be related etiological factors.

The author concludes that Little's disease is not a distinct clinical entity and that, at present, it is not possible to find a cause which applies indiscriminately to all cases.

—*H. M. Childress, M.D., Dallas, Texas.*

AN OPERATION FOR PARALYSIS OF THE INTRINSIC MUSCLES OF THE THUMB. N. D. Royle. *Journal of the American Medical Association*, CXI, 612, Aug. 13, 1938.

The author presents a new method of muscle transplantation for paralysis of the intrinsic muscles of the thumb.

The operation is performed as follows: A transverse incision is made at the base of the fourth finger and the bifurcated sublimis tendon is released at its insertion. The sheath of the flexor pollicis longus is opened and the sublimis tendon is drawn down through the sheath. One part of the bifurcated tendon is sutured to the attachment of the short flexor muscle with the first phalanx in flexion, and the other part is fixed to the outer edge of the opponens pollicis with the thumb in opposition. The sublimis tendon itself is used as the suture material. The thumb is immobilized for about ten days.

The sublimis tendon to the third or the fifth finger may also be used for the transplant.

The author has employed this operation during many years, with satisfactory results.

—*E. P. Legg, M.D., Dallas, Texas.*

THE PATHOLOGY OF CARIES SICCA OF THE SHOULDER. Henry Turner. *Messenger of Surgery*, LI, 83, 1937.

Prof. Turner, of Leningrad, in his study of the literature on tuberculous arthritis, points out that the involvement of the joint, the pathology, and the clinical course in the so-called "caries sicca" differs very definitely from tuberculous affections in other joints. The name was given by Volkmann to designate the acute affection accompanied by atrophy of the bone, but without suppuration. The pathology at that time was not

portant. It is a problem for the orthopaedic, the psychological, and the educational fields.

There are two general types of injury which may cause cerebral spasticity. The cortical type of injury, due usually to unskilled use of forceps, produces definite spasticity. The basilar type, due to hemorrhage into the basal nuclei from a tear of the tentorium and the vein of Galen, produces athetosis, tremor, or incoordination. Either of the two forms of palsy may result from a congenital defect or from encephalitis.

A distinct differentiation must be made between spasticity and athetosis, since the treatment for each is not the same. The repetitive method of instruction, for instance, is valuable for spastic cases, but is generally unsuccessful in teaching athetoid patients. The athetoid child reacts to his involuntary motion by voluntary tension. This becomes habitual if he is not taught to relax as much as possible. Thus relaxation must be the foundation upon which future progress is made.

A regimen of treatment should be mapped out and properly timed for each individual case. Instruction should be given in simple motor coordination, behavior regulation, and the simplest control of psychological reactions to situations. Surgery is indicated most often in the spastic group. In severe athetosis, however, section of the lateral columns of the cord may be of some benefit.—*E. P. Legg, M.D., Dallas, Texas.*

PROTRUDED INTERVERTEBRAL DISKS. J. Grafton Love and Maurice N. Walsh. *Journal of the American Medical Association*, CXI, 396, July 30, 1938.

The authors base their report upon 100 cases of protrusion of intervertebral discs. It was noted that most of the discs were found in the region of the greatest convexity or concavity of the spine. This was accepted as indirect evidence that the lesion is secondary to mechanical trauma, since the vertebrae at these areas are subjected to great strain.

In 84 per cent. of these cases there was a definite history of intermittent symptoms. This periodic pain is explained by the fact that in some instances the projected disc returns to its normal intervertebral position, particularly following kyphotic flexion. This fact was verified in a cadaver.

There were eighty-eight cases of protruded lumbar discs. A history of injury was definitely connected with the onset of symptoms in only 34 per cent. Unsuccessful were efforts to determine the exact site of the lesion by means of reflex changes, muscle weakness, and segmental sensory loss. In the majority of cases the sensory impairment occurred in segments below the actual lesion. This may be explained by pressure on the roots of the cauda equina as they pass over the bulging disc. Total protein of the spinal fluid was forty milligrams or more per 100 cubic centimeters in 80 per cent. of the cases studied.

The operative procedure consisted of either extradural or transdural removal of the protruded portion of the disc. The removal of two spines and two laminae usually gave sufficient exposure. The articulating facets were preserved, the ligamenta flava were removed for lateral approach, and the iodized oil was removed at operation. In no case was a spine fusion done, and in no instance was there a return of the patient's original symptoms.—*H. M. Childress, M.D., Dallas, Texas.*

INFANTILE CEREBRAL PALSY (SPASTIC PARALYSIS). Clarence H. Heyman. *Journal of the American Medical Association*, CXI, 493, Aug. 6, 1938.

This paper is based on 1000 cases of cerebral spastic paralysis. The author recognizes the importance of birth trauma as an etiological factor, but believes that it has been given undue prominence.

The term "Little's disease", as now used, includes every type of palsy developing at or from the time of birth. There should be further division, as Little's disease,

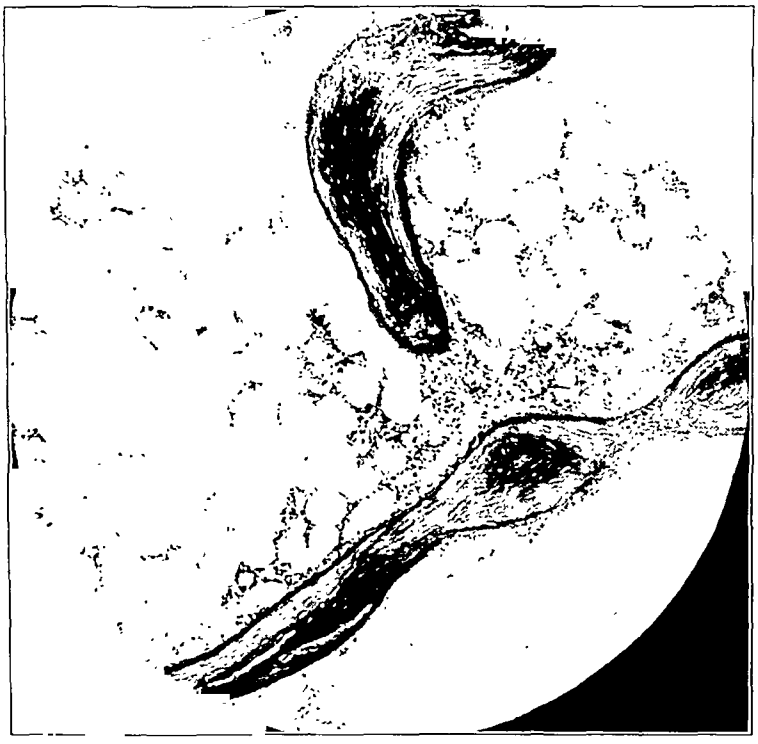


FIG. 5



FIG. 4

Fig. 4: Photomicrograph illustrating scattered areas of bone resorption accompanied by extensive alveolar hemorrhage. (See Figure 2, *b*.)
Fig. 5: Photomicrograph illustrating both well-advanced alveolar disintegration and trabecular resorption. (See Figure 2, *c*.)

understood, but Volkmann differentiated the condition from those that are associated with the usual forms of tuberculosis, syphilis, or chronic affection.

The description of Volkmann was so definite and so accurate that it has frequently been repeated by other writers who have dealt with this subject, and it has been shown that the destruction of the head of the humerus is principally concentrated in the tubercle and the anatomical neck. According to König, the destructive process is originally located in the sulcus between the tubercles. The subchondral part of the head then undergoes dissolution. Codman states that there is no other disease of the shoulder in which the sulcus is so depressed and enlarged at the expense of the head. It is generally believed that the synovial membrane is not visibly affected, yet the most marked element in the clinical syndrome is contraction of the capsule and the ligaments. Loss of motion, approaching ankylosis, is the inevitable result. As far as is known, there is no special relationship between age and this particular affection.

Prof. Turner states that his interest in this particular condition became active many years ago, and was stimulated by his observations of the insidious and continuous pain in the shoulder and the adjacent regions, and of the rapid impairment of function and the very marked atrophy of the deltoid. Accompanying the atrophy in children, there is marked retardation of the growth of the upper end of the humerus, with a shortening of its entire length. A careful examination of the anatomy and the correlation of the component parts of the syndrome suggest a nerve involvement as the explanation of this form which differs so largely from the ordinary tuberculous joint. Further study reveals evidence of the involvement of the axillary (circumflex) nerve in the early stages of the process. Since its structure corresponds in type to the short nerves, which are principally muscular in their distribution, the axillary nerve regularly gives off a sensitive branch to the integuments of the posterior part of the shoulder. This branch is known as the cutaneous brachii lateralis, and arises from the fifth to the seventh cervical roots. The upper branch winds around the neck of the humerus beneath the deltoid as far as the anterior border of this muscle, giving off cutaneous branches. The lower branch distributes filaments to the teres minor and to the posterior process of the deltoid. The nerve then pierces the deep fascia on its way to the integument between the posterior part of the deltoid muscle and the long head of the triceps. The articular capsule also receives its sensitive innervation from this nerve.

From the anatomical findings, which establish the fact that the axillary nerve controls the power, the sensation, and the function of the shoulder, it would appear that in disease of the shoulder joint the toxic condition affecting this nerve will have an important effect on the structures in this region. Toxic neuritis as a complication of tuberculous arthritis is recognized, although frequently not sufficiently so. In the treatise by Dejerine on diseases of the nervous system, tuberculous neuritis is ranked among the other toxic forms. With the recognition of the affection of the motor and trophic elements of the axillary nerve in caries sicca, it became of further interest to demonstrate the involvement of the sensitive cutaneous filaments of this same nerve trunk. Investigation disclosed a definite area of extreme cutaneous sensibility on the posterior portion of the shoulder below the lateral part of the crista scapulae.

In the examination of the fresh pathological specimens, in conjunction with material obtained by clinical observations, Prof. Turner was particularly impressed by the appearance of two cases in which the humerus showed a considerable amount of shortening. (See Figures 1-A and 1-B.) Examination of these specimens revealed the peculiar destruction combined with a very definite degree of shortening of the humerus as compared with the humerus on the opposite side. In one of the specimens, all traces of the upper epiphysis had disappeared and a newly formed flat surface was observed on the posterior part of the shaft for articulation with the scapula.

The author states that the question might easily be raised: Wherein lies the special propensity of this nerve to be involved in the toxic process originating in the shoulder joint? In few other joints can there be found such close proximity to the skeleton of the main nerve trunk supplying all component parts of this joint. The bicipital groove

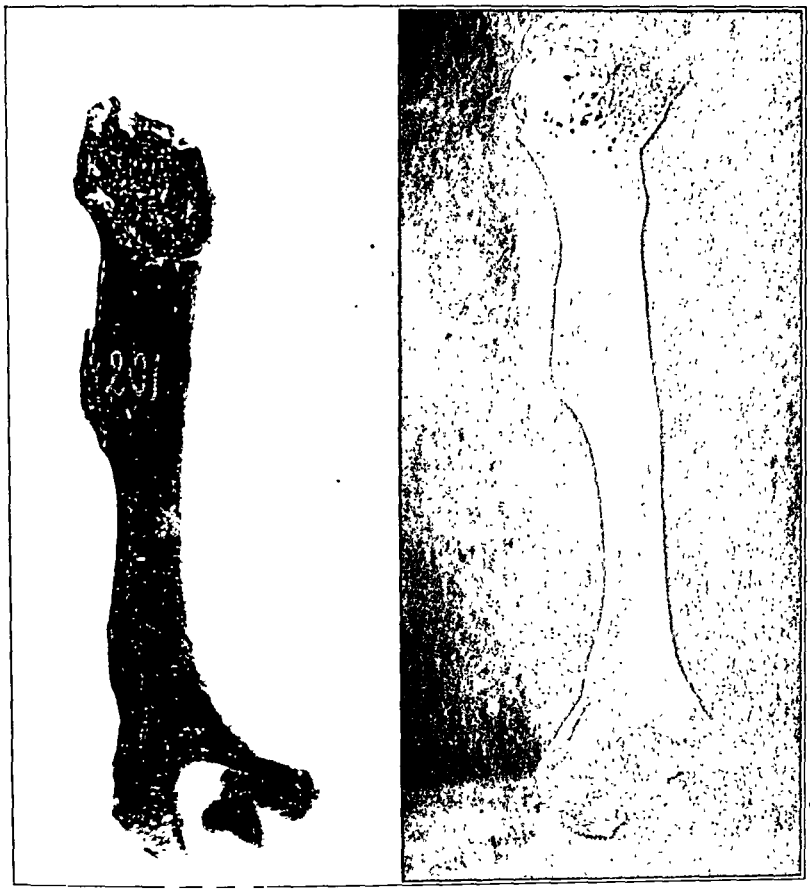


FIG. 1-A FIG. 1-B

Two cases of caries sicca of the humerus.

Fig. 1-A: Final stage, showing flattened surface.
Fig. 1-B: Final stage of destruction of the upper end.

serves as a pathway for the gravitation of the toxic material produced in the epiphysis, thereby exposing the nerve to its action. Definite nerve manifestations of the trophic type may then overbalance the immediate effect of tuberculous destruction and produce the indolent dry course of the disease which, up to the present time, has eluded explanation. It is further suggested that the continual atrophic process aids the tendency of the caries sicca toward a spontaneous termination, although after destruction of the joint of many years' duration.

Prof. Turner adds a word in regard to the clinical experience with treatment based upon this theory. In several cases, in an endeavor to obtain the curative effect of treatment of the nerve, he resorted to intra-articular injections of tincture of iodine into the space between the acromion and the head of the humerus, with the hope that the resultant gravitation would aid in freeing the contracted capsule. This procedure was repeated at intervals of weeks and proved to be particularly efficient in these cases.

In this article, Prof. Turner has attempted to explain the unusual course of tuberculous arthritis known by the name of "caries sicca", and he suggests that an early involvement of the axillary nerve by the toxic process, with the resulting trophic disturbance of the entire joint, is responsible for the peculiar clinical characteristics found in this condition.

Spätergebnisse nach Sehnenoperationen im Bereich der Hand (End Results of Tendon Operations in the Hand). E. Derra und G. Ruberg. *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, XLV, 20, June 1938.

The authors report the end results of tendon operations in the hand, as observed in the *Chirurgische Universitätsklinik*, in Bonn. On the basis of their studies, they feel convinced that operative correction of severed tendons is in order, with the possible exception of old untreated cases. There is no marked difference between the results obtained in the flexor tendons and those in the extensor tendons. The authors urge primary suture in every possible instance rather than secondary suture, because of the difference in results obtained in the two groups of cases. It is impressed upon the reader that painstaking care of the wound is essential, with particular attention to antisepsis and the technique of suturing. Preferably, the simplest types of suturing procedures are employed. While it is the belief of these authors that the milder injuries may be treated in the Out-Patient Department—particularly when only one tendon is cut—the more severe injuries should be treated in the hospital. It is desirable that this type of injury be handled by one especially qualified to do this kind of work.—*I. William Nachlas, M.D., Baltimore, Maryland.*

Bumper Fractures of the Tibia. Hubbard T. Buckner. *Northwest Medicine*, XXXVII, 102, Apr. 1938.

This fracture is described as a separation of the lateral condyle of the tibia, and is often difficult to retain in place after reduction, even though the leg is held in a plaster cast. It sometimes even escapes roentgenographic detection. The author advocates passing through both condyles a doubled wire with a button at either terminus. The fracture is reduced by a "redresser" vise and the wires are tightened by a special turnbuckle and twisting. Four cases are illustrated by roentgenograms.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

Shelving Operations of the Hip. John F. LeCocq. *Northwest Medicine*, XXXVII, 107, Apr. 1938.

The author describes his operations for forming a shelf over a dislocated femoral head without too much traction placed upon the femur, and for increasing the size of the upper rim of the shallow acetabulum. He advises such operations in all cases of painful dislocated hips or painful shallow acetabula in young adults and in children over ten years of age. Roentgenograms of three cases, before and after treatment, are shown.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

Partial Deforming Spondylitis and Trauma. Traumatic Discosis as a Source of Spondylosis. M. I. Kagan. *Novy Khirurgichesky Arkhiv*, XXXIX, 50, 1937.

The material of study is based on 526 cases of spine injuries observed in the Sklifasovsky Institute of Traumatology from 1932 to 1936.

The author states that the partial deforming spondylitis may be due either to a previous degenerative process of the intervertebral disc or to an acute or chronic injury of the spine. The source of the deforming traumatic partial spondylitis is a chronic traumatic discosis. The rupture of the cartilage and bone plates caused by an injury produces a herniation of the elements of the intervertebral disc, especially of the nucleus pulposus into the spongiosa. The traumatic discosis differs from Schmorl's nodules in that the cartilage plate may not be injured but may show a hyperplasia and abnormal development. In chronic discosis of non-traumatic nature the deformity of the vertebral body never reaches the degree observed in traumatic discosis. Discosis with a wedge deformity of the vertebral body may present diagnostic difficulties, but the clinical picture and the x-ray study will establish the proper diagnosis. The presence of sclerosis

in the spongiosa around the herniated elements and the localization of the destructive process in the cranial and caudal cartilaginous plates will distinguish the chronic process from acute trauma, where no sclerosis is found and where, as a rule, the cranial plate only is impaired.

The author presents a number of x-ray reproductions illustrating the described condition.—*Emanuel Kaplan, M.D., New York, N. Y.*

NEW OBSERVATIONS IN CONGENITAL DISLOCATION OF THE HIP IN THE NEW BORN. V. O. Marx. *Orthopaedia i Traumatologia*, I, 25, 1938.

The incidence of congenital dislocation was found to be 1 per cent. in normal births and 11 per cent. in breach presentations in a group of 8544 infants born in Kharkov in 1937. In the past five years 194 children with congenital dislocation of the hip were under actual observation.

The author observed a large percentage of spontaneous reductions. He states that spontaneous reductions were noted in the first few days of life in 47.4 per cent. and in later months in 17.5 per cent. of cases studied in the special maternity institution of Kharkov.

The treatment consisted in the early application of a duraluminum apparatus. The author presents an analysis of the treated cases and summarizes his conclusions as follows The most reliable sign of a very early dislocation is the presence of slipping, and all the others are of secondary importance; preluxation is much more frequent in breach presentations; spontaneous reductions in the first days of life are a frequent occurrence but must be under observation for two to three and one-half years. The disappearance of clinical and x-ray evidences of dislocation in early life may not coincide with a definite reduction.—*Emanuel Kaplan, M.D., New York, N.Y.*

MALADIE DE STEINERT SANS MYOTONIE (Steinert's Disease without Myotonia). Roma Amyot. *La Presse Médicale*, XLVI, 188, 1938.

The author reports a case of familial hereditary atrophic myotonia. Despite the marked muscle atrophy and loss of deep reflexes, there was no electrical reaction of degeneration. The patient presented numerous stigmata, such as pigmentation of the skin, hypercholesterolemia, diminished metabolic rate, bilateral cataract, and bradycardia, suggesting a pleuriglandular syndrome rather than an involvement of the basal ganglia. Glycocoll, ephedrine, and thyroid extract were given without any amelioration of the symptoms.—*Henry Milch, M.D., New York, N. Y.*

PATHOLOGIE DE L'IMAGE DE SOI. LES HALLUCINATIONS DES AMPUTÉS. ÉTUDE CLINIQUE ET PATHOGÉNIQUE (Amputation Hallucinations). Jean Lhermitte et Zvonimir Susic. *La Presse Médicale*, XLVI, 627, 1938.

The authors undertook a study of twenty-eight cases in which the patients ranged in age from thirty-nine to eighty years. One or more amputations had been performed from three to forty-six years before the study. Occasionally the patients experienced pain in the amputated extremity at variable times, although localization of pain usually came on directly after operation. The pain appeared to be intensified by fatigue and by change of weather. At night and during sleep, the pain frequently became so severe as to waken the patients.

As a consequence of their clinical analyses and experimental studies by means of calcium-gluconate injections, the authors make a definite distinction between the pain specifically located in the stump and that referred to the amputated extremities. This latter type of pain, contrary to the general opinion, is not due to local conditions in the stump, but is to be referred back to the central nervous system. In the opinion of the authors, this pain can only be understood as a psychological and pathological manifestation of the proprioceptive sense.—*Henry Milch, M.D., New York, N. Y.*

TRAITEMENT DES PARALYSIES SPASMODIQUES. RADICOTOMIE POSTÉRIEURE (Posterior Radicotomy in Treatment of Spastic Paralyses). M. Yovtchitch. *La Presse Médicale*, XLVI, 689, 1938.

The author is of the opinion that, in the treatment of spastic paralyses, the simple procedures should be employed before the more complicated ones are attempted. Apart from reeducation, tenotomy is the most valuable. Osteotomies and joint stabilizations have not been used. The author feels that sympathectomy is of no special value, since it yields only a transitory hypotonia. Stoffel's operation gives only slightly better results than simple tenotomy and should be employed only in the mild cases. For the severe cases, the Förster operation is the method of choice. It gives immediate and lasting relief of the athetosis and the hypertonia. However, since reeducation is an essential part of the treatment, the operation should not be performed unless there is a moderate background of intelligence. The risks and the gravity of the operation have been overestimated.—*Henry Milch, M.D., New York, N. Y.*

INTRADERMIQUES DE SANG DANS LA DOULEUR RHUMATISMALE (Intradermal Injections of Blood for Rheumatic Pain). J. Calvé. *La Presse Médicale*, XLVI, 956, 1938.

Aron and others have noted that intradermal injections, regardless of the material used, exert an analgesic action. By some, this has been attributed to a sympathetic reaction to the injury; by others, it has been explained as being due to the liberation from the tissues of a histamine or a histidine-like substance. This mechanism may explain the results obtained by acupuncture as practised by the Chinese, as well as the success which has followed the use of friction or superficial cautery.

The author has employed this principle in the treatment of rheumatic patients. Autogenous blood was used: first, because autohemotherapy has been shown to have a stimulating effect on the reticulo-endothelial system; and, second, because it seems to intensify the histamine-like action of the puncture. Twenty cubic centimeters of blood are drawn into a syringe containing one cubic centimeter of 10-per-cent. sodium-citrate solution. The skin over the painful joint is disinfected, and several drops of blood are then injected intradermally in a number of spots, from two to three centimeters apart. The remainder of the blood is injected intramuscularly. The injections are repeated every four days.

This method has been used in cases of varied nature, including periarthritis of the shoulder, coxarthritis, lumbago, sciatica, lumbar arthritis, sacro-iliac arthritis, etc. The author reports a number of cases as "cured" (including three cases of chronic rheumatism), several as improved, and one as unimproved.

Although the author is convinced that the injections alone will give satisfactory results, he notes that, in forty-two cases, two cubic centimeters of sulphurated natural oil, containing two and thirty-four one-hundredths centigrams of organic sulphur, were given over a period of from ten to twenty days. The author expresses the opinion that this ensures more rapid results.—*Henry Milch, M.D., New York, N.Y.*

ROENTGEN THERAPY OF DUPUYTREN'S CONTRACTURE. S. R. Beatty. *Radiology*, XXX, 610, May 1938.

The surgical treatment of Dupuytren's contracture is a somewhat formidable procedure; hence, an effective method of treatment which is without dangers and which does not interrupt the patient's routine of living is desirable. There is practically no literature on the treatment of this condition by irradiation.

The author reports the use of irradiation in ten cases, and gives details of the conditions present and of the technique of treatment used.

Seventy per cent. of the treated cases showed very definite improvement; there was marked relief of the contracture in two cases in which the contracture was of an advanced stage.—*Edward N. Reed, M.D., Santa Monica, California.*

HAMMER TOE. THE CUP AND BALL PROCEDURE. A. Tierny. *La Pratique Chirurgicale Illustrée* (Edited by Victor Pauchet, Ed. 2, Paris, G. Doin & Cie), IX, 265, 1937.

This procedure, first described by the author in 1924 and used in about twenty cases, has the advantage of saving the articulations of the toe. The operation is performed

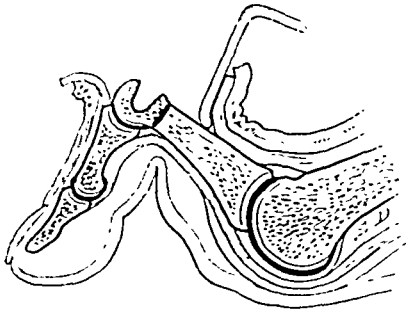


FIG. 1

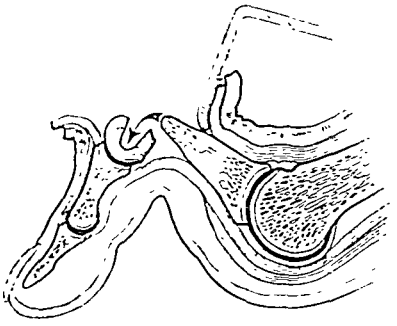


FIG. 2

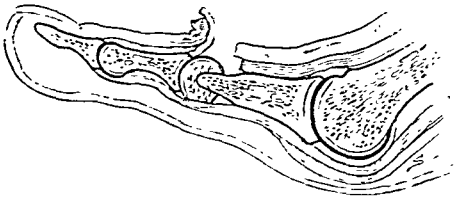


FIG 3

under local anaesthesia. An elliptical incision is made, with excision of the bursa and skin; the extensor tendon is cut transversely and lifted off the joint; a small hole is bored in the head of the proximal phalanx slightly behind the center of the articular surface; the neck of the phalanx is then severed from the body of the phalanx proximal to the hole; and the cut end of the body of the proximal phalanx is reshaped to fit the hole bored in the head. When completed, the cut surface of the head is directed downward. The cut ends of the extensor tendon are reunited and the wound is closed.

The successive steps of the operation are illustrated in Figures 1, 2, and 3.—*Emanuel Kaplan, M.D., New York, N. Y.*

BONE (CALCIUM) METABOLISM IN RELATION TO INDUSTRIAL INJURY. W. Warner Watkins. *Radiology*, XXXI, 59, July 1938.

The skeleton is considered not simply as a framework for the body, but also primarily as a storehouse for calcium. Bone is not a fixed and stable tissue, but is capable of undergoing rapid and striking changes. Calcium and phosphorus are not inert minerals, whose whole function is to give hardness and stability to bone, but are essential and vital in the general metabolism. Calcium is rapidly removed from the bones when needed elsewhere in the body.

In bone development or repair, calcium is deposited in a preformed connective-tissue matrix; and the more primitive the type of tissue, the more perfect the bone formation.

Bodily needs require a constant level in the blood stream of from nine to eleven milligrams of calcium per 100 cubic centimeters of blood. The intake of calcium must maintain this and provide enough more for osteogenesis and bone repair.

Vitamin D is essential to promote the absorption of calcium from the intestine. Parathormone maintains the calcium level in the blood stream, but it does not influence its deposition in bone. The calcium brought by the blood stream to the bone is changed by an enzyme, phosphatase, into the form which is most easily deposited. Whether phosphatase is secreted by the osteoblasts, and what other function these cells may have in osteogenesis, is not definitely known.

There are various types of bone atrophy, — nutritional or starvation, due to dietary

deficiency; disuse atrophy; senile atrophy; neurotrophic atrophy; and the acute reflex atrophy originally described by Sudeck, which is due to disturbance of the sympathetic-nerve control.

Certain metabolic diseases cause the calcium to be dissolved out of the bones. One of the most striking of these is the so-called "renal rickets", in which failure to eliminate phosphorus by the kidneys causes the withdrawal of calcium from the bones in order that it may combine with and render inert this retained phosphorus.—*Edward N. Reed, M.D., Santa Monica, California.*

TRATAMIENTO OPERATORIO DE LAS FRACTURAS DIAFISARIAS IRREDUCTIBLES DEL ANTEBRAZO (Open Reduction of Irreducible Diaphyseal Fractures of the Forearm). A. F. Gutiérriez Solís. *Revista de la Policlinica Caracas*, No. 37, December, 1937.

In treating displaced diaphyseal fractures in the forearm, perfect function is obtained only with perfect apposition. When satisfactory closed reduction is not obtained, the points of fracture are exposed promptly and the fragments brought in apposition by intramedullary grafts or by suturing with kangaroo tendon or No. 3 chromic catgut. Twenty-three case reports (with photographs) prove the open method advisable.—*Edward Francis Keefe, M.D., New York, N. Y.*

VARIOS ESTANDARTES DE CIRUGÍA DE GUERRA (Some Standard Treatments of War Surgery). M. Bastos. *Revista de Sanidad de Guerra*, September and November 1937.

For gunshot fractures of the arm, the author employs a method which prevents systemic complications, severe osteomyelitis, gangrene, and pseudarthrosis. Wounds of the soft parts are thoroughly cleansed, but are sutured only in cases where stretching of the surrounding skin is not necessary. Bone fragments should never be removed, even when they appear to be dislodged. The arm is immobilized in a plaster cast, in 45 degrees of abduction, with the elbow at a right angle and the wrist extended. The author warns against putting the arm in a horizontal position, as well as against the application of extension: first, because of possible healing of the humerus in a curved position; and, second, on account of the risk of non-union. The plaster remains unchanged for from four to eight weeks; after this time, a new cast is applied. As soon as roentgenograms show bony union, the cast is removed, and the patient starts to move the shoulder.

Amputation should never be done if circulatory conditions are good. The lack of pulse at the wrist is not a conclusive symptom; immediate amputation is indicated only if the hand is cold and gray in color and shows clear signs of gangrene.

In cases of wounds of the main vessels of the limbs, the author states that ligature results in no ill effects in the arm, because there circulatory disturbances are of no importance. In the leg, on the contrary, the consequences of ligature are most unfortunate, for gangrene usually follows. For that reason, the author performs systematic amputation in such cases.—*Francisco P. Dueño, M.D., Madrid, Spain.*

CONTRIBUCIÓN AL ESTUDIO DE LA PATOLOGÍA DE LAS FRACTURAS RECIENTES DEL CUELLO DEL FÉMUR Y LOS FUNDAMENTOS DEL TRATAMIENTO OPERATORIO DE ESTAS FRACTURAS (A Contribution to Pathology and Surgical Treatment of Recent Fractures of the Neck of the Femur). J. y M. D'Harcourt. *Revista de Sanidad de Guerra*, June 1937.

Recent fractures of the neck of the femur without dislocation of the fragments should be treated by non-operative methods. Abduction fractures with penetration of the fragments ought to be fixed in a Whitman plaster spica. When manipulation does not succeed in coapting the fragments and keeping them together, operative treatment should be employed. The authors advocate the use of the Smith-Petersen or the Felsenreich nail. The operation is performed after the technique of Sven Johansson,—that is, the wire is inserted and check-up roentgenograms are taken before the nail is definitely fixed in place.—*Francisco P. Dueño, M. D., Madrid, Spain.*

CONSIDERACIONES SOBRE EL TRATAMIENTO DE LAS HERIDAS DE GUERRA DE LA MANO (Considerations on the Treatment of Gunshot Wounds of the Hand). V. Sanchís. *Revista de Sanidad de Guerra*, August 1937.

During the first twelve hours, all destroyed tissues are removed and the skin wound is sutured without drainage. After this period the author advocates mechanical cleansing of the wound and open treatment. The extensor tendons are sutured when it is possible. The accompanying fracture of one or more metacarpals is reduced and the wrist is immobilized in a "cock-up" plaster splint. A wire splint is used for the extension of the digits in the flexed position.—*Francisco P. Dueño, M.D., Madrid, Spain.*

LE FIBRO-CARTILAGE DE L'ARTICULATION RADIO-CUBITALE INFÉRIEURE CHEZ L'ADULTE (The Fibrocartilage of the Inferior Radio-Ulnar Joint in the Adult). J. Guillermo. *Revue d'Orthopédie et de Chirurgie de l'Appareil Moteur*, XXV, 125, March 1938.

The author calls attention to the fact that injuries to the discus articularis produce painful arthritis and limitation of pronation and supination. These injuries are associated with fractures of the wrist, or they may be present without accompanying bone fractures. The anatomy, physiology, and pathology of this important but overlooked ligament are described. A clinical picture of a lesion is presented. The author compares this fibrocartilage to the meniscus of the knee. The treatment recommended by the author consists in complete removal of the discus articularis under local anaesthesia.—*Emanuel Kaplan, M.D., New York, N. Y.*

FRACTURE DU TRAPÈZE (Fracture of the Greater Multangular). Fernando de Moraes *Revue d'Orthopédie et de Chirurgie de l'Appareil Moteur*, XXV, 217, May 1938.

The newer notions of anatomy of this region are given, and a minute analysis of the mechanism of fractures of the greater multangular is presented. The treatment is prolonged immobilization after reduction by continuous traction applied to the thumb in abduction. The author believes that if this treatment is not effective the removal of the bone is the method of choice.—*Emanuel Kaplan, M.D., New York, N. Y.*

ANOTHER METHOD OF PINNING FRACTURES OF THE NECK OF THE FEMUR. Joseph Madison Greer. *Southwestern Medicine*, XXII, 213, June 1938.

The author calls attention to the greater incidence of healing in impacted fractures of the femoral neck as compared with the cases where impaction is not present. He notes that most nails, wires, and other fixation devices used in femoral-neck fixation do not maintain impaction for the entire duration of the time necessary for the fracture to become firmly healed, as the friction between the bone and the metal becomes lost with bone absorption about the metal fixation device. Accordingly he has devised a screw that will maintain solid impaction for the duration of the healing period. This screw, the end of which is a modified corkscrew, is designed to rest entirely within the capital fragment. It presents a broad surface at almost right angles to the capital axis and thus affords a firm anchorage for strong traction and for compression or impaction. The screw penetrates easily without previous drilling and without displacement of the fragments. When the screw is in place, the trochanter fragment is forced against the head fragment by means of a trochanter catch, which prevents rotation of the screw and maintains effective impaction. The technique for inserting this screw is as follows:

1. Reduce the fracture by the Leadbetter method.
2. Take roentgenograms in two views.
3. Prepare and drape the patient on a fluoroscopic table for operation.
4. While viewing the area through the fluoroscope, hold one point of the forceps over the center of the head and another just below the base of the trochanter where the screw is to enter the femur.

5. Mark these two points with a dye and draw a line between them.

6. Make an incision over the trochanter, and insert the screw parallel to the table top and along the line drawn on the skin. Be sure that the leg is in internal rotation.

7. Take a roentgenogram to be sure that the screw is going in properly; then screw it all the way in, put the lock catch and nut on its shank, and screw down tightly.

This procedure is simple, can be done rapidly, and the end results are excellent.—*Herbert E. Hipps, M. D., Marlin, Texas.*

TREATMENT OF DISLOCATION OF THE SHOULDER. Henry Milch. *Surgery, III*, 732, May 1938.

The author cites a case of spiral fracture of the humerus occurring during Kocher's manipulation for dislocation of the shoulder. He advocates the use of a method which he calls "abduction, external rotation, and pulsion", not only for the uncomplicated acute dislocations but also for fracture-dislocations as well. Reduction may often be accomplished without the use of an anaesthetic.

The patient lies in the supine position, while the surgeon takes his place on the side of the dislocation. In a right-sided dislocation the surgeon places his right hand upon the patient's right shoulder, so that the fingers find firm support on the top of the shoulder, while the thumb is braced against the dislocated humeral head. The right hand fixes the head while the left hand gently abducts the arm into the overhead position. During this manoeuver the head of the humerus is supported so that it cannot move from its dislocated position. As a consequence, instead of moving downward as the arm moves upward, the head rotates in place. In this manner the tendency to stretch further already stressed nerves is obviated. As the arm is abducted, it is gently rotated externally to release the twisted capsule, according to the principles described by Kocher. Once the arm has been brought into complete abduction in this overhead position, all cross-stresses exerted by all the muscles have been eliminated, and the head can be gently pushed over the rim of the glenoid and the dislocation reduced.

THE RELATIONSHIP OF THE INTERVERTEBRAL DISK TO BACK STRAIN AND PERIPHERAL PAIN (SCIATICA). Joseph S. Barr. *Surgery*, IV, 1, July 1938.

The author reports fifty-eight cases, from the Massachusetts General Hospital, of posterior protrusion of the intervertebral-disc tissue into the lumbar spinal canal in which there was pressure on one or more roots of the cauda equina. The patients complained of intractable leg pain involving the posterior thigh, lateral calf, and sometimes the low back or foot. On examination, the characteristic findings of "low-back strain with sciatic scoliosis" were usually present. The lumbar spine was flat or kyphotic with a fixed list to one side. Straight-leg raising was limited chiefly on the side of the pain. In many cases there was tenderness at the lumbosacral junction or at the next higher spinous interspace. The neurological findings varied from negative to those of complete flaccid paraplegia. An absent or diminished ankle jerk was the most common finding.

The ordinary roentgenograms were of little use in diagnosis, but fluoroscopic examination after the injection of lipiodol localized the lesion with a very high degree of accuracy. The author emphasized the necessity of considering this diagnosis in every case of sciatica and back strain, but reserved the use of lipiodol for those cases which showed obvious signs of nerve-root pressure or which had failed to improve under adequate conservative treatment. Laminectomy and removal of the protruding disc tissue gave relief in all but three of the fifty-eight cases. There was one operative death.

THE SURGICAL TREATMENT OF LOW BACK PAIN. Alan DeForest Smith. *Surgery*, IV, 13, July 1938.

About 90 per cent. of all patients admitted to the Clinic of the New York Orthopaedic Dispensary and Hospital with the complaint of pain in the low back were relieved

by non-operative measures, about 5 per cent. were subjected to lumbosacral fusion, and the remaining 5 per cent. refused operation. The author stressed the necessity of eliminating the cases of spinal-cord tumor, arthritis, etc., by a thorough physical examination.

Mechanical insufficiency at the lumbosacral articulations was considered to be the cause of symptoms in most of the cases. The sacro-iliac joints were considered to be at fault very rarely.

Changes in the lumbosacral angle, abnormal lateral articulations, posterior displacement of the fifth lumbar vertebra on the sacrum, defects in development of the laminae, sacralization of the transverse processes, and degeneration of the lumbosacral intervertebral disc were among the most common predisposing factors found.

The Hibbs type of fusion, occasionally using additional bone from the ilium, was employed in all cases. In the majority of cases the fifth lumbar vertebra and the sacrum only were fused.

Excellent or good results were obtained in between 80 and 90 per cent. of a "large series" of these cases treated by lumbosacral fusion. Failures were due: first, to non-recognition of the presence of arthritis; and, second, to inability to obtain fusion.

In cases of low-back strain with sciatica, division of the fascia lata alone or in combination with spine fusion gave excellent results.

RELATION OF THE FASCIA LATA TO MECHANICAL DISABILITIES OF THE SPINE. Frank R. Ober. *Surgery*, IV, 21, July 1938.

The author reviewed and discussed in detail the anatomical relationship of the fascia lata to the muscles and bones of the junction of the thigh and pelvis. He pointed out that fascial contractures accounted for certain physical variations; i.e., increased lordosis, limitation of straight-leg raising, pelvic tilt, etc. Certain cases of chronic lame back and sciatica were associated with fascial contractures and were relieved by stretching or by division of the tight structures. Fasciotomy was reserved for those cases in which other organic lesions were excluded.

SURGICAL TREATMENT OF AFFECTIONS OF THE LUMBOSACRAL AND SACRO-ILIAC JOINTS. Joseph I. Mitchell. *Surgery*, IV, 33, July 1938.

In this article, the late Dr. Mitchell enumerated the causative agents affecting the spine and producing low-back pain, in order of frequency, as follows: (1) infection, (2) congenital anomalies, (3) trauma, (4) postural defects, (5) tumors. He discussed briefly the differential diagnosis of lumbosacral and sacro-iliac affections and described the technique (Campbell) of extra-articular fusion of the sacro-iliac joint. In certain cases fusions were combined by laying grafts between the ilium, the sacrum, and the transverse process of the fifth lumbar vertebra. He reported excellent results in 77 per cent. of the non-tuberculous cases and in 61 per cent. of the tuberculous cases.

GIBT ES EINE DEM MORBUS KÖHLER II ANALOGE AFFEKTION AUCH AM KÖPFCHEN DES OS METATARSALE I? (Is There a Köhler's Disease of the Head of the First Metatarsal?) Heinrich Breitenfelder. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 181, 1937.

Köhler's disease of the heads of the second, third, and fourth metatarsals has frequently been described. The fifth metatarsal does not seem to be affected at all, and the first metatarsal only rarely. This has been attributed to the protection given by the two sesamoid bones. Typical necrosis of these sesamoid bones has been described. Other authors consider the arthritis juvenilis of the basal joint of the hallux (the hallux rigidus) to be related to Köhler's disease. The author then describes a case of Köhler's disease of the first metatarsal, basing the diagnosis upon the roentgenographic appearance as compared with roentgenograms of Köhler's disease of other metatarsals.—*D. H. Bruns, M.D., Iowa City, Iowa.*

Ein Beitrag zum Krankheitsbild der Vertebra plana Calvé [Vertebra Plana (Calvé)]. W. Marquardt. *Zeitschrift für Orthopädie und ihre Grenzgebiete*, LXVI, 343, 1937.

Bülow and Hansen, in 1924, reported a case of Köhler's disease of a thoracic vertebra. Calvé also described a case in 1924. Twenty-seven cases have been reported to date. The author has observed a similar case of six years' duration. A boy of four years became suddenly ill with abdominal pain and backache. A small gibbus was found, and the roentgenogram showed a typical vertebra plana.

Sundt studied twenty-one cases and found that the patients ranged in age between two and fifteen years, most of them being five years old. The onset was usually acute, with severe abdominal pain. A small gibbus or kyphos, with muscle spasm and pain in that region, was found. There was no elevation of the temperature nor appreciable change in the blood picture. Roentgenographic examination in each case showed the vertebra flattened to a small disc and dense. In either projection the edges seemed to bulge over the neighboring intervertebral disc. The intervertebral discs showed normal height. In the course of months or of one to two years the vertebra revascularized and increased in height, although it usually never attained more than one-half of its normal height. In a few cases neurological pathology (compression) was present. Treatment consisted in recumbency and the application of a brace.—*D. H. Bruns, M.D., Iowa City, Iowa.*

Die Heilung von habitueller Schulterluxation und Kreuzbandruptur des Kniegelenkes mittels Eigenblutinjektionen (The Treatment of Habitual Dislocation of the Shoulder and Rupture of the Cruciate Ligaments of the Knee with Autogenous Blood Injections). Felix Mandl. *Zentralblatt für Chirurgie*, LXIV, 1030, 1937.

The operative reconstruction of cruciate ligaments in the knee in cases of traumatic rupture of the cruciates is a very formidable procedure, which has been completely abandoned by the author. Instead he obtains about ten to twenty cubic centimeters of whole blood from the cubital vein of the patient and injects it into the joint capsule of the knee. This injection is repeated from five to ten times at intervals of from two to three days. Since July 1935, the author has injected sixty-four knees, with complete disappearance of the "drawer" symptom and restoration of joint stability in 75 per cent. of the cases. In those cases of rupture of the cruciate ligaments where there are additional injuries that require operative procedures, the blood is introduced into the capsule through the operative wound. There were no complications following these injections except an occasional hyperaemia in the region of the knee joint, which always disappeared in a short time.

These injections have also been used successfully in a number of cases of habitual dislocation of the shoulder in which operative intervention was contra-indicated. These intracapsular injections bring about a shrinkage and contracture of the capsule, which becomes firm and strong enough to maintain the stability of the joint.—*Harold Unger, M.D., Iowa City, Iowa.*

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row. The bone trabeculae were smooth in outline. The alveolar arrangement was undisturbed, and the sole deviation from the normal shown in this specimen consisted of a few scattered areas of hemorrhage evidenced by minute collections of red blood cells.

In the section shown in Figure 4 there was much hemorrhage and round-cell infiltration. The bone trabeculae were hazy in outline and in many places were lined with osteoclasts. Adjoining bone marrow showed some beginning disorganization and was vacuolated in areas.

Figure 5 demonstrates marked disorganization of the fatty alveolar structure. Certain areas are filled with red blood cells. A trabecula with a hazy periphery is shown, and around the tip in the center there are a large number of osteoclasts. Normal bone lamellae are seen in the periphery of the section.

## DISCUSSION

On the basis of these findings one may definitely conclude that this case was doomed to non-union as a result of almost complete necrosis of the neck as early as eight days after fracture. The focal necrotic spots in the head show that the blood supply to this area was very deficient and probably would have accelerated bone destruction. This case is presented to emphasize the necessity for extremely accurate reduction in this type of fracture. In this particular instance the result was fore-ordained, regardless of the type of treatment. The wide-spread necrosis in this case may be present in varying degree in all cases. It is this factor which probably puts this lesion in a class by itself. We do not feel that the insertion of the bone screw was responsible for necrosis, as it was *in situ* only a few hours. If, however, this screw acted as a necrotizing agent, then any form of internal fixation in this type of fracture is questionable.

The problem involved in the treatment of this type of fracture is far from settled and further studies of this nature will aid in its solution. It may be that visualization of the fracture site may be necessary before the proper type of treatment can be selected.

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# RECONSTRUCTION OPERATIONS FOR OLD UNUNITED FRACTURES OF THE NECK OF THE FEMUR *

BY E. G. BRACKETT, M.D., BOSTON, MASSACHUSETTS

The object of this paper is not to advocate any one method of treatment of old ununited fractures of the neck of the femur, but, rather, to present a few observations on the subject as a whole. The treatment of this condition is a problem for the solution of which a great deal has of late been offered, but it seems that frequently the essential factors have been somewhat overshadowed by the emphasis given to certain methods of technique, forms of apparatus, etc., rather than to the application of definite and well-established principles of treatment to the various conditions met with in this affection. Special surgical procedures have been given more prominence than the study of the particular indications which each case presents and on which the selection of the method of treatment depends.

The recent interest in this subject is evidenced by the large number of papers which have been presented. These contributions are not necessarily an indication of the difficulties met with in the course of treatment or of concern with the general problem, but, rather, of interest in new or modified methods of technique and mechanical devices, many of which are not remarkable for originality or for any special difference from the original. We may question whether the emphasis on these details is not suggestive that sufficient attention has not been given to the selective adaptation of those measures which we already possess and of technique with which we are already familiar.

To the surgeon who is occupying himself with the operative problem in this treatment, the special technique is not particularly important, for he will be able to apply his surgical skill to any operation. It is, rather, the application of his individual skill and experience to the special procedure which he may choose as best adapted to the case in hand. The important factor is his choice of procedure. It is not so much a question of whether or not union of the fragments can be obtained by one of the recognized methods as it is of whether or not the fragments of the joint are of sufficiently normal structure to allow the joint to function in a satisfactory manner after it has been restored. In the one case, we may choose one of the methods which promises union; in the other, we should make no attempt to restore the architecture of the joint, but should content ourselves with a joint which has limited function. After making this decision, the surgeon can then select the technique which in his judgment is best suited to the task.

In making a decision in regard to the choice of the treatment to be

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selected, the following features are to be taken into account: the character of the break; the amount of absorption of the neck; the size of the head and the amount of atrophy; the condition of the acetabulum and, in fact, of all the remaining structural elements of the joint which may be used in restoring function by whatever method the operator may decide to employ. Of equal importance with the local factors are the general factors,—namely, the age; the general condition; the amount and kind of activity engaged in by the patient; and the demands which his social status will put on the restored joint.

The various accepted methods of operation, with their modifications, can be easily put into two groups, according to the principles upon which they are based and the goal which they attempt to reach:

1. Those which, in the presence of intact articular structures, aim to preserve the parts and to restore as far as possible the normal architecture of the joint.

2. Those which, in the absence of normal joint structures, are destructive in principle and aim to use non-articular structures to perform a portion of the rôle of the normal joint structures.

The former attempts to restore to the joint a large percentage of normal function; the latter makes no such attempt, but, with the use of other non-articular structures, endeavors to regain as much of the normal function with weight-bearing as existing anatomical conditions can with reason promise. The employment of the first type presupposes the presence of articular structures sufficiently normal to resume joint function when the architecture has been sufficiently restored; the other accepts the damaged parts as a fact and endeavors to use them to the best advantage, recognizing that an imperfect joint must be accepted as a final result. Each case calls for an estimate of its potential capacity for function, based on the condition of the joint structures which remain.

In this estimate, it is necessary to formulate the essentials of a normal joint,—namely, (1) normal area and line of the joint cartilage; (2) freedom from arthritic changes; (3) preservation of a reasonable degree of bone density of the head fragment. It is a fact that some degree of change in the structure of an uninjured joint is compatible with satisfactory use, but it must be recognized that, after so severe an injury, these changes gradually become more pronounced, with a resultant increasing incapacity. Therefore, when these articular changes exist, even if they are not pronounced, the joint is not likely to stand the test of time and of the stress of an active life. These facts must be reckoned with in planning for the late end result, and these local conditions must influence the choice of procedure. Along with this, the social status of the patient makes equally strong demands for recognition and often must be the important deciding factor. The decision, therefore, must be made as to whether we shall attempt to restore, as far as possible, the normal architecture and function of the joint, or whether we shall compromise and be content with a less perfect end result.

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